NSECT PESTS
AND
OW TO BEAT THEM

JAMES SARSFIELD

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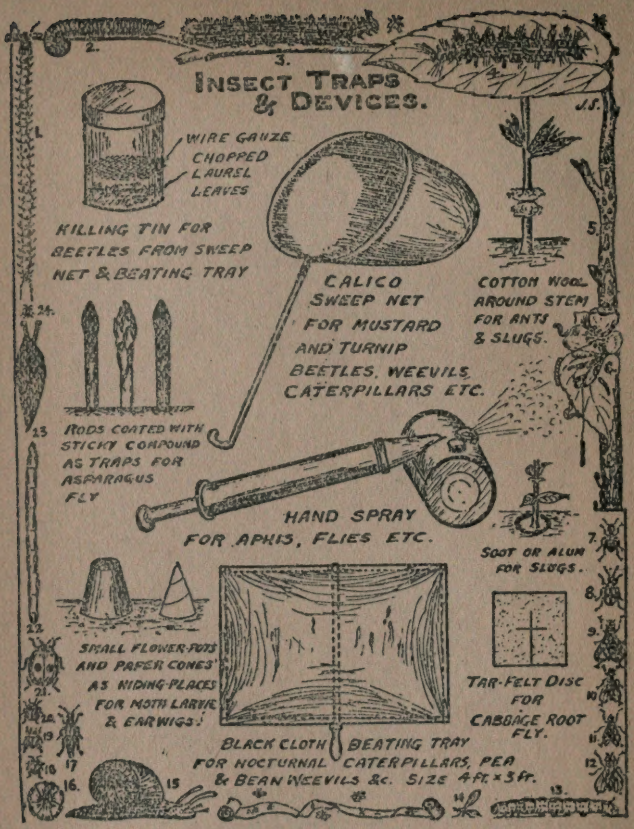
INSECT PESTS
AND HOW TO BEAT THEM



REFERENCE TO SPECIMENS IN BORDER

1. Centipede, an insect eater.
2. Millepede, a plant eater.
3. Lackey Moth Larva.
4. Gold Tail Moth Larva.
5. Mussel Scale on Apple Bark.
6. Winter Moth Larvæ on Apple Blossom.
7. Common Garden Ant.
8. Asparagus Beetle.
9. Asparagus Fly.
10. Cabbage Root Fly.
11. Beet and Mangold Fly.
12. Onion Fly.
13. Cabbage Moth Larva.
14. Carrot Fly.
15. Garden Snail.
16. Armadillo or Pill Insect, encouraged on neglected ground.
17. Insect-hunting Rove Beetle.
18. Turnip Flea or Hopper.
19. Turnip and Cabbage-flower Beetle.
20. Mustard Beetle.
21. Lady-bird.
22. Wireworm.
23. Black Garden Slug.
24. Black or Bean Aphis.

INSECT PESTS

and

HOW TO BEAT THEM

Including Notes on Plant Diseases, Soils and Manures

BY

JAMES SARSFIELD

WITH ILLUSTRATIONS OF EVERY INSECT DESCRIBED IN THE TEXT

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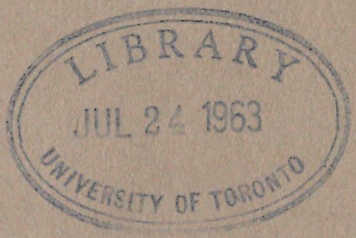

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PREFACE

THE old-time sage who wrote, "of the making of books there is no end" can hardly, I think, have had the subject of Insect Pests in his mind at the time of his inspired remark, for although there are numbers of books on insects in their various classes, those which take up the pest question itself are relatively few. It is therefore hoped that the present little volume will prove of value to those engaged in the production of food.

The main difficulty that comes to a writer on pests is that of choosing out of the multitude of examples those which are most likely to be met with throughout the country generally, and the selection herein given will, I trust, meet with this requirement.

The notes on soils and manures were added for the benefit of beginners, on the ground that the best way to resist pests and diseases is to ensure plant health in the first instance.

As regards the theories dwelt on here and there and in the last chapter I offer these for what they are worth to those who take a student's interest in the subject, but for speedy reference purposes a careful index has been added, as a time-saver for use in the height of the season. Pests are with us however at all times, and a glance at the Vigilance Chart at the end will illustrate the importance of this to the grower.

In conclusion I must acknowledge the help obtained from the publications of the Board of Agriculture as well as the ready assistance afforded by the Editor and Staff of the *Smallholder* in the preparation of this volume.

JAMES SARSFIELD.

October 1919.

INSECT PESTS AND HOW TO BEAT THEM

CHAPTER I

THE SMALLHOLDER AND INSECT PESTS

THE subject of insect pests from the smallholder's standpoint has become of such importance to-day that the present volume has been written with the object of endeavouring to assist growers to cope with a danger that must inevitably become serious unless handled on intelligent lines.

It has become a commonplace to say that when war came upon us the British nation arose most wonderfully to the great call of the times, and that there is no man worthy of the name who ought not to feel proud of citizenship in this Empire. This was evinced in no direction more markedly than with the great group of new growers and allotment workers who, in spite of initial inexperience, and in spite of the slow-coach policy of various Councils and Authorities, have literally worked wonders with the soil.

Now comes an important aspect of the situation. We have got on to the land, a large number of us, and we are not going to be turned off again with a mere vote of thanks or a paragraph in the daily paper. Things will go hard in certain places if we do not establish our claim as growers, important items in our small way in

the great land policy which must make these islands practically independent and self-supporting.

But no amount of legislation will prevent caterpillars from eating cabbages. Here we are like the Barons at the time of the Black Death, when about half the population were wiped out. The goodly Barons, scenting danger to their purses, went to Westminster and passed a nice little law to the effect that no workman should have more wages than he had hitherto received. They then went straight home and paid double wages rather than let their neighbour sing a siren song to the few men who were left. They were up against an economic law, in face of which Parliament is powerless. It is the same with natural laws, except that they are much more drastic; and if we complain of an insect pest which comes along seemingly out of pure "cussedness," we should remember that there is a definite cause for its appearance, and a definite remedy must be found sooner or later. Clearly, then, a little sound knowledge of entomology, picked up by the grower in his spare time, is not only interesting but highly profitable, and I shall endeavour to show in the chapters that follow, avoiding the technical side as much as possible, how such knowledge can be gained and how to apply it to the ends we have in view.

I was once introduced to a man who had given up his ordinary handicraft to chance his luck as a market gardener, in the days when the grower's trade was the least paid of any calling. He did it because he liked it, and didn't like his former work.

Yet this man, who had surrounded himself with everything his heart desired, from grape-vines to blackberries, from orchids to mustard and cress, gave me the impression of being thoroughly disheartened with it all. I felt sorry for him. He looked tired and overworked, with the drawn appearance of a man who never has any rest on a Sunday, and never has time to tidy himself up and

go out for a change. It made me want to find out what his real trouble was, and as we were going round the establishment together, I happened to let out something about entomology, when, like the famous ointment, I found I had immediately touched the spot.

My new-found friend at once began to pour out a host of both real and imaginary evils. To quote his own words, as near as possible, he said, "It's like this, sir, so soon as ever you get a decent crop of anything, there's bound to be some 'blarmed' creeping insect come along, and all your work goes for nothing." He then described the work of many insects I was well acquainted with, and also went on to expatiate upon the ravages of others quite unknown to me or indeed any one else, "uncommon artful 'blighters' that do the double shuffle and vanish even while you look at 'em, then come back as soon as you've moved off and start fresh."

Of course it is only the unexplained that is mysterious, and the sooner we get a working knowledge of the species referred to in this book the better for our food-crops. We shall see that there is more variety, more beauty, more ingenuity and more danger in the insect world than in any other department of Nature. And it is inextricably mixed up with the history of plants. In fact, as regards the person above mentioned I could see that curiously enough he had made exactly the same mistake as had happened to me many years ago when I first began to study insects. He had clearly gone at the business of gardening from the elementary standpoint, "for growing plants learn all about plants." I confess my own mistake was quite as bad, but I soon found it impossible to get very far in the one subject without obtaining a working knowledge of the other.

There is, therefore, the strongest reason why the grower should make himself something of an insect-hunter in more senses than one. The way in which the police

get hold of criminals is to turn up their records, and the more we know about a weevil, a moth or an aphis, the more likely we are to be able to chase it down to the point of absolute disposal.

In the chapters which follow, I propose to deal with the question of insect pests from the smallholder's point of view and grouped as shown in the chapter headings. The illustrations will give the reader a clear idea of the appearance of the creatures which are troubling him, and in the descriptions the actual size is expressed in inches.

I have retained the Latin names, because, as is well known, the English ones vary in different parts of the country, and sometimes even different insects are included under one name. The scientific or "Latin" name, on the other hand, is one by which each insect is known throughout the world.

Before proceeding to deal with the pests categorically, it will perhaps be convenient to many readers to explain that there are Nine Great Orders of insects, grouped in various ways according to various authorities, under one or other of which the different families we shall presently meet with must come, and if we can recognize the order to which our pest belongs, we are well on the road to discovering its history.

Beginning, then, with the lowest forms, we have MYRIAPODA, or many-footed creatures, including Centipedes, Millipedes, "Pill" insects, Woodlice and the Armadillo. They pass through no elementary stages in their growth, and by some are thought to be scarcely insects at all, but joint-bodied animals, or articulata, first cousins to the spider. (See Plate 1.)

As a general rule they are not very harmful to the gardener, as, excepting the millipede, which gnaws at roots, they feed upon decaying animal and vegetable matter. Where their presence is objected to, such matter should be rigorously collected and removed.

Next come the SUCTORIA, or Suckers, including Fleas

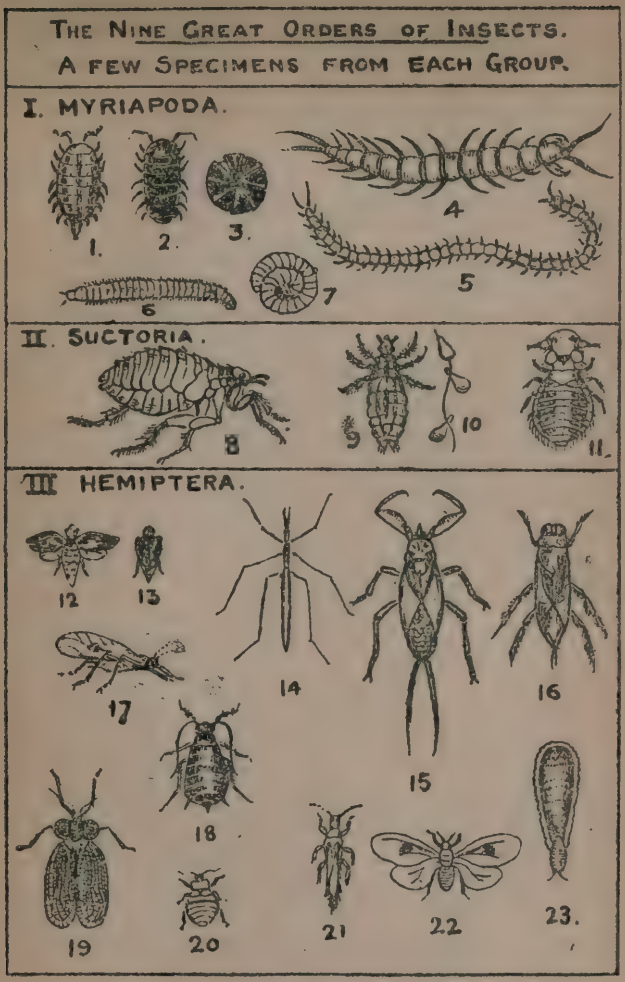

PLATE 1.

1. Wood-louse.
2. Armadillo or Pill Insect.
3. Ditto, rolled up.
4. Centipede (*Lithobius forcipatus*).
5. Centipede (*Geophilus longicornis*).
6. Millepede.
7. Ditto, rolled up.
8. Human Flea.
9. Louse.
10. Eggs or "nits" of same, on hair.
11. Hen Louse.
12. Frog Hopper or Cuckoo Spit Insect.
13. Frog Hopper or Cuckoo Spit Insect with wings closed.
14. Pond Skater.
15. Water Scorpion.
16. Water Bug.
17. Rose Aphis.
18. Black or Bean Aphis.
19. Pear Tree Bug.
20. House Bug.
21. Bean Thrips.
22. Snowy Fly.
23. Mussel Scale Insect.

and Lice, which infest unclean animals. These, like the preceding class, are Apterous, or wingless creatures. Their larvæ live in dirt. We need concern ourselves no more with them than to say that the mere suggestion of cleanliness will cause them to turn up their eyes in pious horror, and the carrying of it out will cause them to turn up their toes, which is more to the point.

We may now proceed to the HEMIPTERA, or Half-Wings, which embrace the various kinds of frog-hoppers, pond-skaters, plant lice, water scorpions, etc. These are true insects, and pass through several elementary stages before they are full grown. In the main they feed upon the juices of living plants, and are distinctly inimical to the farmer and the gardener.

DIPTERA, or Two-Wings, are the gnats, midges, daddy-long-legs, blue-bottles and house flies, etc. They undergo the customary four stages of the higher insects,—viz., ova, larva, pupa, imago,—or, in plain English, egg, maggot, chrysalis, and perfect fly. Some of the larvæ are aquatic and form very interesting studies. Others, like the Blow Fly, infest meat in hot weather, whilst certain species are parasitic on the larvæ of other insects, chiefly butterflies and moths. (See Plate 2.)

The ORTHOPTERA, or Straight-Wings, consist of the grass-hopper, crickets, cockroaches, earwigs, etc., chiefly devourers of plant life and therefore become pests. The terrible locust of the East belongs to this class. The larvæ live beneath the soil and are voracious eaters of roots. Certain crickets, however, hunt down flies and other insects.

We now pass to the NEUROPTERA, or Nerve-Wings, which comprise dragon-flies, lacewing flies, caddis flies, etc. The larvæ are mainly aquatic, but in their perfect state these insects hunt down and destroy butterflies, plant lice and other small species.

Next are the famous HYMENOPTERA, or Membrane-Wings, including ants, bees, wasps, ichneumon flies

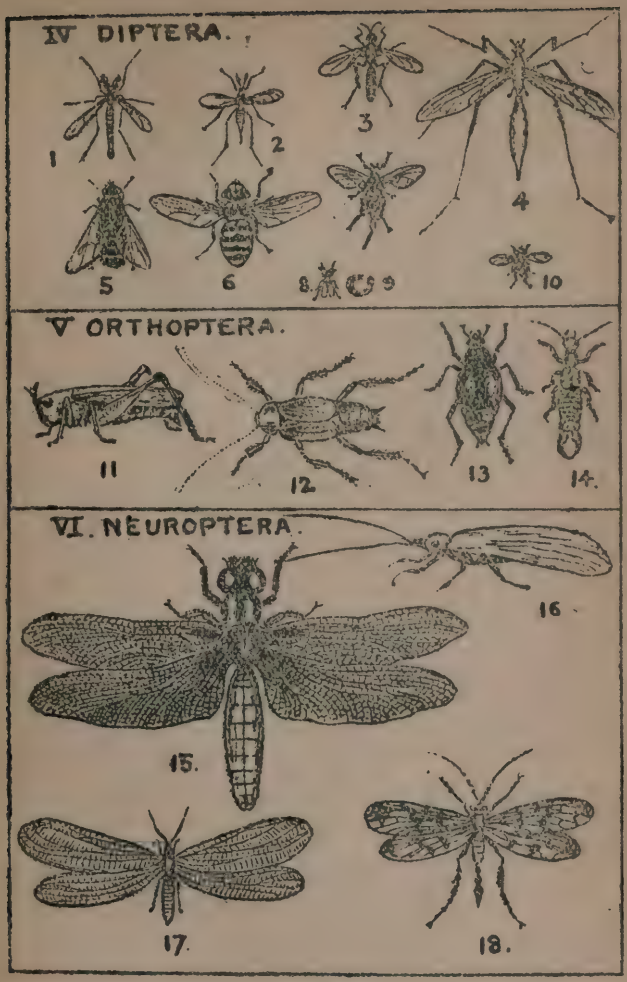

Plate 2.

1. Gnat.
2. Wheat Midge.
3. Moth-eating Empis or Hawk-fly.
4. Daddy-long-legs.
5. Blue-bottle Fly.
6. Insect-hunting Hover Fly.
7. Ribbon-footed Corn Fly.
8. Cheese Hopper Fly.
9. Ditto, Maggot of same.
10. Frit Fly.
11. Common Brown Grass-hopper.
12. Cockroach or "Black Beetle."
13. House Cricket.
14. Earwig.
15. Dragon Fly.
16. Caddis or Stone Fly.
17. Green Lacewing Fly.
18. Common Scorpion Fly

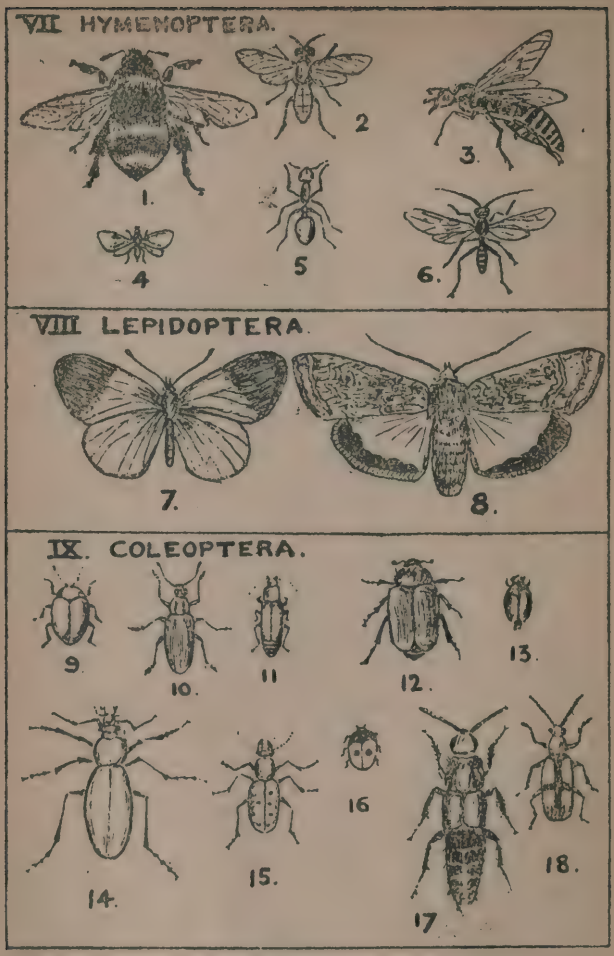

PLATE 3.

1. Humble Bee.
2. Saw-fly.
3. Wasp.
4. Small Ichneumon Fly.
5. Yellow Meadow Ant.
6. Large Ichneumon Fly.
7. Orange Tip Butterfly.
8. Yellow Underwing Moth.
. Mustard Beetle.
10. Bean and Pea Weevil.
11. Click or Skipjack Beetle.
12. Cockchafer.
13. Whirligig Water Beetle.
14. Insect-hunting Ground Beetle.
15. Tiger Beetle.
16. Two-spot Lady-bird.
17. Rove Beetle (*enlarged*).
18. Asparagus Beetle.

saw-flies, etc. Amongst these, if we rule out the wasps and saw-flies, we have the aristocrats of the insect world, and leaving out of account the crowning example of the honey-bee, they are most useful to man as fertilizers of flowers and persecutors of harmful tribes in the other orders. The Hymenoptera are usually provided either with a sting or a powerful set of jaws, which they use in self-defence. (See Plate 3.)

The eighth class are the LEPIDOPTERA, or Scaly-Wings, divided into butterflies and moths, the main difference between them being seen in the antennæ or feelers, which in butterflies are knobbed at the ends, whilst those of moths are nearly always tapered off in a fine point.

In their larval state certain species of these insects are a serious menace to crops, notably the Cabbage Whites and the Cabbage Moth, which have been exhaustively studied, and of which more later. Most of our beautiful British butterflies, however, such as the lovely Fritillaries, Red Admirals, Peacocks and Blues, are harmless, and should remain as an ornament to the countryside, as in their caterpillar form they merely eat up nettles, thistles and low-growing herbage, and also, as perfect insects, give a lot of help in the fertilization of flowers. (See Plate 12.)

The COLEOPTERA, or Case-Wings, include all the true beetles, aquatic or otherwise, and are easily the most numerous and most diverse kind of insects in variety of habits, uses and abuses. A proper study of British Beetles would more than occupy a lifetime, but here we shall be confined to the pests themselves, their parasites and larger species which devour them. The larvæ of beetles are found everywhere—in the water, in the soil, in the stems of plants, in the heart of flowers, in dusty corners of rooms, hidden away in damp cellars, and buried in the midst of manure heaps, or revelling at the roots of meadow-grass and amongst all kinds of rotted

wood and decayed vegetable and animal matter. Many so-called field "fleas" are really beetles.

Pests are of two distinct kinds, indigenous or native, and exotic or introduced from abroad. Of these the latter are often the worst, as when an immigrant finds congenial surroundings it usually revels in its new home, like the rabbit in Australia, and the brown or grey rat which invaded this country about a century ago and practically exterminated the English black rat, leaving us in a much more serious condition than before. Another case is the common dock, which was introduced into New Zealand by a rascally merchant who sold it as tobacco seed and the thing became almost ineradicable. In America there is the Gipsy Moth, as they know to their cost, and so on. Nature seems to object to her plans being interfered with and to retaliate accordingly.

This brings us to consider our last point. Why do pests come? The answer is simplicity itself. Because we invite them. In other words, knowingly or not, we provide board and lodging on a grand scale which the new-comer is not slow to take full advantage of.

We have therefore to fight for our crop and defend it against its prey. It is an inexorable law which has existed for countless ages. There is no species at present on the earth which has not had to fight for its place in life. The original dragon-fly, for instance, a fearfully clumsy arrangement something like four tennis rackets screwed to a ninepin, was persistently hunted down by the flying dragons of the Liassic period. But it managed to hold on, on the principle that "doggedness does it," I suppose, and although they are now both extinct, the children of the dragon-fly exceed in strength and variety those of its former foe, which is now represented by a bat.

So it goes on. The best wins, and the question is, are we going to let the insects win, or are we going to

make our food-crops secure by employing the natural means at hand to resist attack, supplemented by the artifices of science? At all events it is clear we must divert, somehow, the first onset of the pest, so that, finding the conditions unfavourable, it will be well kept in hand if not altogether exterminated.

Nature varies her tactics in the case of the fungoid diseases. Here a healthy, microscopic plant is absorbing the juices and tissues of a weak and unhealthy host, whereas in the case of the insects the more robust our crop the better they like it.

We shall look further into the question of fungi at the close of the book, as it is a subject which is as important to the grower as insects.

In the following chapter I have included some of the pests which are troublesome to farm stock, as they all come under one or other of the insect groups above referred to and their study is just as necessary to the farmer as those species which prey upon crops.

With regard to the various remedies suggested, almost all of these are well known. It will be seen, however, that I have put forward as often as possible such manual aids as egg search, hand picking, pupa digging, etc. Also the encouragement of all natural checks. The reason for the first is because I think that this kind of help, which can often be done by children if they are properly instructed, is more efficacious than the use of chemicals in washes and dressings, at any rate for the small man. In the case of natural checks I think it is obvious that these, being automatic, are highly profitable.

I do not profess to give a panacea for all insect troubles, but so far as my own experience goes, I am convinced that the proper handling of the pest question can only come about by the food-grower and the insect student joining forces. That is why, at the risk, perhaps, of some readers' patience, I have made

this opening chapter somewhat of a natural history lesson ; but in the rest of the work I shall endeavour to deal as succinctly as possible with the straightforward issue, " Insect Pests, and how to beat them."

CHAPTER II

FARM PESTS

Ailments of farm stock—Ailments due to insects—Ox Warble Fly—Horse Bot Fly and Gad Flies—Sheep parasites—Nostril Fly—Blue-bottles and Green-bottles—Keds or false Ticks—Sheep Scab and Tick Mite—Liverfluke—Pigs and Tapeworms—Poultry parasites, external and internal—Bee pests—Insects injurious to field crops—Clover Weevil—Eelworms—Antler Moth—Frit Fly—Ribbon-footed Corn Fly—Hessian Fly and Wheat Midge—The Mole Cricket—Corn Thrips—Corn Aphis—Grain Moth and Corn Weevil—Ear-cockles—The rat question—Mustard Beetles—Root crops and the Turnip Moth.

WE now take up the story in earnest, and as we are dealing with insects as a whole it will be necessary to pay some particular attention to those species which are injurious to farm stock. In pre-war days many English farmers used to look upon their stock as their mainstay, and farm animals must of course always take the first place in the eyes of the agriculturist, as without them it would be quite impossible to carry on. There is nothing truer than the saying that a farmer is never done learning, and this remark applies to stock more than anything else. Their ailments are many, and it hurts a good farmer to see his beasts suffer and not know the cause or the remedy. Of course he always sends for the vet., which is much the safest plan, but a little handy acquaintance with the causes of some of these

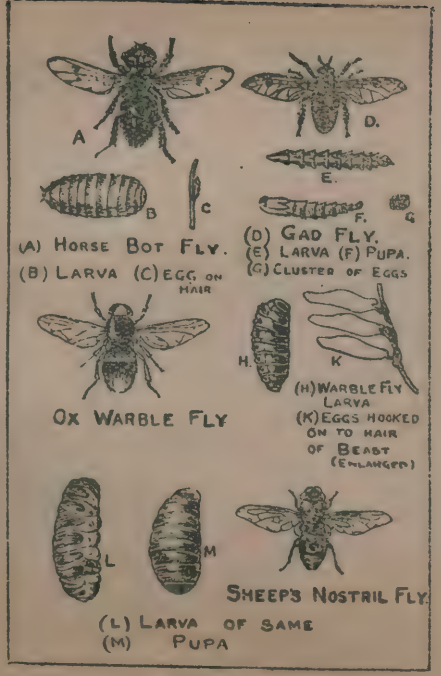

Plate 4.
Stock Pests

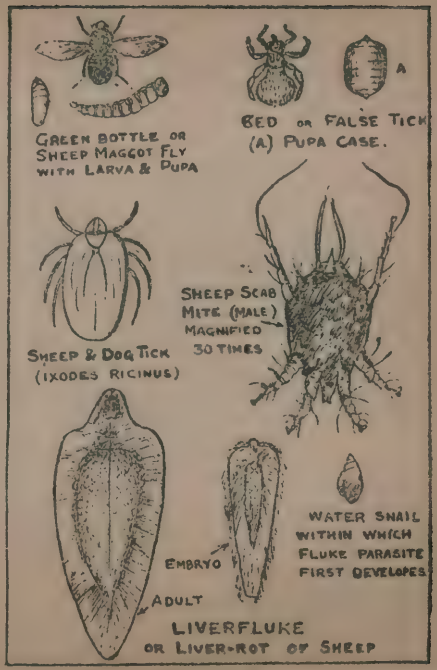

Plate 5.
Sheep Parasites.

ailments is bound to be useful, and so we shall here examine a few farm pests that belong generally to the insect world. These divide naturally into two sections, viz. insects injurious to stock and those harmful to field crops.

The numerous diseases of stock are due to the attacks of many other creatures besides insects. For instance anthrax, swine fever and erysipelas, foot and mouth disease, glanders and tuberculosis are caused by bacteria or viruses. Ringworm is an animal fungus; so is the trouble called hard tongue or lumpy jaw in cattle. Husk or hoose in calves is caused by worms in the tubes of the lungs, whilst the disease called redwater is due to the presence of a minute germ or protozoon in the blood. We are here, however, chiefly concerned with insects, and stock pests under this head are almost always dipterous or two-winged flies.

We may take as our first example the Horse Bot Fly (*Gastrophilus equi*), which is yellowish in colour and somewhat like a Blue-bottle in appearance, in fact it has been called the Yellow-Bottle. It lays its eggs on the hair of the fore-legs, mane and neck, and the maggots which hatch from them find their way down the horse's gullet and so to the interior, where they finally attach themselves to the walls of the stomach and feed upon the juices therein. When full-fed they leave go, and pass out to change into glossy brown pupæ, which hatch as complete Yellow-bottles in due course. After being out at grass all animals should be examined for the eggs, and also, if the Bot Flies are thought to be established, a draught of linseed oil and turpentine will be found beneficial once a fortnight.

The Gad-flies and Forest-flies are insects of the same tribe and similar in appearance to house flies. These do not infest horses during the larval state, being aquatic, but the females come in the hot weather to suck their blood, and cause great suffering in some years. The draught horse is unfortunately too often deprived of his

flowing mane and sweeping tail, which were given him for the express purpose of slashing those flies, and whenever we encumber him with harness we should endeavour to make up for such limitations by a rubbing down with a paraffin cloth and the fixing on of leafy twigs during the day time to give him some chance against the gad-flies.

The Ox Warble Fly (*Hypoderma lineata*) also belongs to the Diptera. Its habit is to hover about for a couple of hours or so at mid-day in the hottest time of the year, the flight being accompanied by an even, sustained humming sound. This sound has a remarkable effect on cattle, who seem to know by instinct the meaning of it, and it causes them to stampede, suddenly rushing off without any apparent object or reason, and, if they can, they will take shelter or enter a stream, either of which alternatives should be available, as the judgment of the animal is perfectly right and the flies will not follow them there. This stampeding, however, becomes a serious matter with cows, either milch or in-calf, as it may cause a poor yield in the one case, and loss in the other. Such is the action of the adult flies : but that is by no means all. This insect has a larva or " bot " which lives as an internal parasite of oxen. The female fly lays her eggs in summer time upon the hair, chiefly of the legs, and each egg is firmly attached to the hair by means of claspers and a gummy secretion. A sketch is shown of this peculiar egg. It hatches in a day or two into a spiny maggot, which irritates the skin so that the animal licks the place and so carries the young bot into its mouth and it passes down the throat, thus reaching the interior after penetrating the wall of the gullet. The bot then changes its skin and becomes smooth and " slithery " just like the common maggots of " blown " meat, which are the progeny of the Blue-bottle. The young bot is now able to wander about among the tissues of its host, at last settling just between the flesh and the hide. There it moults and again becomes spiny, as shown in the sketch.

Bots at this stage cause much suffering to the poor beast; a swelling comes up, called the warble, the skin being perforated with a hole at the top. The blood and pus formed under these warbles provides the food of the bot, and as it approaches maturity it thrusts its tail out of the hole in the hide. It finally drops to the ground and changes to a black pupa, from which emerges the perfect fly at various times from June to September.

What can possibly be the use of such disgusting, even malignant insects, asks some one? I am not going to make apologies for the Ox Warble Fly or any other stock pest. One cannot look upon it with any sort of indulgence, nor as yet are we acquainted with any natural remedy to be called in aid. The reason for the Warble Fly's existence is that it is part of the scheme of evolution, whereby the various species of animals and plants on the earth are always being determined, often by the most unsuspected agents, and this has always been going on from the beginning of time. If we have been producing unusual numbers of beasts by a wrong principle, which could never be indigenous, then the bot flies and other parasites will assuredly win the day. We must endeavour to give our stock the vigour and provide it with the environment which least departs from the natural type and habitat, and in that way in my opinion it will be best fitted to resist parasitical attack.

So much for the theory, but that is no reason why we should relax our diligence in taking this trouble in hand and doing what is humanly possible to diminish it at the present moment. It is best with all insect pests to seek out if we can the weakest stage of development, and knowing that the eggs of the Warble Fly are laid during the hot months, we can, in the case of cows, keep a good look-out for them on the hair and legs. A little practice will work wonders in the detection of these small ova, and every egg thus found and destroyed means a great deal less suffering for the animal. Another time to check

the increase of Warble Flies is at the time when the skin is perforated and the maggot is about to drop to the ground. This may usually be done from February to April. The maggot can be squeezed out with the thumbs and crushed under foot, the wounds being dressed afterwards with mercurial ointment. This will have a distinctly deterrent effect on these flies. Should there be a plague of them, the beasts should be dressed all over with a mixture of cart-grease and paraffin. The Warble Fly itself is black in colour, with whitish hairs, very irritating when coming against the skin. It has a blunt head and strong, thick legs, the size across the outspread wings being nearly an inch. (See Plate 4.)

Sheep are subject to many insect parasites, our first case being the Sheep's Nostril Fly (*Oestrus ovis*) which is of the same family as the Bot Flies just mentioned. It is hairy in appearance and lightish brown in colour, the wings measuring about an inch across when spread out. The insect has the same blunt-looking head as the Warble Fly, which arises in both cases from the fact that these parasites in their mature state have no mouths, and so do not feed as flies, all their mischief being wrought as larvæ. This however is more than enough. The poor sheep have the same kind of uncanny presentiment about the visits of the nostril fly, and as in the last case, exhibit distress, rubbing their noses on the ground or seeking dusty places in a desire to avoid attack. The nostril flies pair in the early summer, and the egg, which is curved or kidney-shaped, is laid around the sheep's nostrils. The maggot at first is white and slender, and has a pair of mouth-hooks directed backwards, by which it can lever its way up the nostril passages and into the cavities in the upper jawbone, where, by setting up irritation, they cause the formation of the secretions that they feed on. The full-grown maggot is nearly an inch long, whitish and striped, and when about to pupate, it works its way down the nasal passage again, and is sneezed out on to the

ground, there to develop in a week or so into the winged insect.

When sheep are restless and in poor condition, and it is found to be due to nostril fly, the infected animals should at once be isolated and prevented from sneezing out the maggots on to pasture. In the case of a valuable sheep, the nasal passage may be syringed with salt water and permanganate of potash; or even the sinus cut into and the maggots removed. Prevention is better than cure, however, and may be accomplished by coating the sides of the salt troughs with tar and fish oil, so that the sheep, in licking the salt, get their noses smeared over with a substance which will repel the attack of the Sheep's Nostril Fly. (See Plate 5.)

But we have not done with Diptera yet. We have had Yellow-bottles, in the case of horses, and now come to Green-bottles and Blue-bottles on sheep. These last belong to the genus Muscidæ, of which the common House Fly is a conspicuous example. The Green-bottle (*Lucilia sericata*) infests the skin and wool of sheep in the maggot stage, causing irritation, much wagging of the tail, inflammation and discharge from sores, with discoloration and consequent loss of wool. The familiar Blue-bottle (*Calliphora vomitoria*) also varies its usual diet of dead or putrid meat to find board and lodging on sheep. The maggots of these flies are familiar to the angler as gentles, wherewith to woo the unwary denizen of lake and stream. *L. Sericata*, as its name suggests, is a shining green fly and measures just over $\frac{3}{4}$ inch across the wings. Like all its kind, it breeds rapidly and continuously during the warm months, sometimes accomplishing the complete life-cycle within three weeks. The eggs are white and tapering, about $\frac{1}{16}$ inch long. They are attached in clusters of twenty to the wool and hatch within a day in the height of summer. When full-grown, the maggot, about $\frac{1}{2}$ inch long, drops off to the ground and there

changes to a shiny, barrel-like pupa, from which it emerges in about fourteen days as a perfect fly.

Cleanliness is the chief preventive measure, especially about the hind-quarters, as all these families of flies are attracted by dirt, in which they prefer to lay their eggs. Carcasses of birds and small mammals, too, if left about to putrefy, instead of being buried for the use of ants and beetles, will afford propagating centres for fly maggots. The sheep dip is of course both remedial and preventive, but its effects do not last more than three weeks or a month, when it must be repeated.

Badly infested sheep should be isolated and the maggots picked out, and when they have been destroyed, the places where the wool is matted or the skin broken should be shorn a little and rubbed with turpentine and paraffin, afterwards dusting with sulphur. Birds, notably the Willow Wren and the Whitethroat, who live on an insect diet, perform great service in catching these flies.

The above are by no means the only pests that trouble sheep, but we have not sufficient space here to take a full survey of them. We have one remaining example among Diptera, and that is the Tick, or False Tick, or Ked, all of which names signify *Melophagus ovinus*, a degenerate wingless relative of the house fly. It causes great irritation and loss of condition, and is a creature about ¼ inch long, brownish grey in colour, and has the unusual property of retaining its eggs and nourishing them on as far as the pupal state before they are deposited. Keds never leave the sheep's wool, or soon die if separated, and after shearing-time it has been noticed that they collect near the neck. The dip is the best cure (arsenic and soda) which must be repeated at intervals of three weeks to destroy odd pupæ which have come through unharmed.

The true Sheep Tick is not an insect, but an Acarus or Mite known as *Ixodes ricinus*, and it does not confine itself to sheep, but can also be the cause of much misery to the faithful collie that rounds them up. Ticks lay their eggs

on damp herbage and these hatch into a "nymph" or preliminary form which is very similar to its parent, but only has six legs, whereas the adult has eight. They fasten themselves on to sheep or other animals and feast upon their blood, dropping off when gorged and returning again later for another orgy. They first appear in March, and again in the autumn, and are commoner on the hill pastures in the north than anywhere else. Here again dipping will be of service, if repeated, to catch those individuals who are "away on leave" as soon as they come back. (See Plate 5.)

We must now pass on to the Scab, *Dermatodectes ovis*, which is another Acarus, and prevalent in places. Let us just glance at its history. The sheep display much restlessness under its attack and bite the affected parts until they become sores, whereupon the Scab Mite moves off to a fresh place, there to produce eggs and continue their evil work. The Mite, when full-grown, is about $\frac{1}{4}\frac{1}{0}$ inch long and has eight legs covered with hairs, its larva having only six, as shown in the sketch. It is not what one would call an inviting-looking creature. Mites of similar appearance but distinct in species produce mange in horses, dogs and other animals, but the mange and the scab mites confine themselves to their own particular host, so that mange from dogs will not produce scab on sheep, who must therefore get it from contact with their own kind or by rubbing against fence-posts, etc., where the mites and their larvæ have been deposited. It is a notifiable disease and dipping must be done under the Sheep-Scab order of 1905.

All the above are external parasites of sheep, but there are one or two internal parasites which claim attention. There is, for instance, the Liverfluke (*Distomum hepaticum*), whose history is a very curious one. Indeed it reveals to us the extent to which all life is under the influence of controlling powers that are far beyond the wit of man to fathom, working out a purpose we cannot guess at, because

even the most seemingly negligible creatures appear to be invested with the "yes" or "no" of some higher creature's continuance on the earth. Take the present instance. A sheep is grazing on the hillside on a hot day, and feeling thirsty comes down to the stream for a drink. In less than a year that sheep is dead, having become an emaciated shadow of what it was! But how can the simple act of going down to the brook be answerable for such a loss? We must investigate without delay. First we shall test the water, and find it quite pure. Then we shall have received the veterinary surgeon's report of Fluke or Liver Rot, obtained from the stream. We return and take out a few bucketfuls of stream bottom and examine it. Here are some tiny snails, no bigger than a glass bead. Let us dissect one and put it under the microscope. What's this? The liver of the snail contains some half-dozen or so tiny oval creatures like that shown in the sketch, and which is exactly like the larger drawing of the liver fluke! It is simply a case of "like parent, like child." And yet sheep don't eat water-snails? No, and we have here a strange life cycle presented to us, where two totally different creatures, a sheep on the hillside and a little water-snail in the brook down below are closely connected with one another by a third creature, a parasite that requires quite an elaborate chain of circumstances to be fulfilled ere it can bring about its complete round of development. The Liverfluke begins its existence as a minute egg, embedded in the droppings of the sheep. It has been found that one female liverfluke can produce over 40,000 eggs, so that there is plenty of margin for loss. Nature always provides abundantly for these cases where there are many chances against the young creature ever reaching maturity; as is also seen in, say, the cod-fish, whose countless thousands of ova are decimated and re-decimated again and again by enemies at every stage of their career from their entry into the world as spawn to the full-sized candidate for Billingsgate market. It is,

happily for the sheep, not only 100 to 1 but 10,000 chances to 1 against the liverfluke egg reaching maturity, but where these sheep droppings are on wet pasture some eggs are bound to get washed down to lower levels where there are streams. Then, after hatching into a swimming embryo it searches out one particular kind of water-snail, *Limnax truncatula*, and bores its way into its body, whereupon the snail suffers from liverfluke, and these embryos produce organisms similar to the adult parasite, with a mobile tail. At this stage they leave the body of the snail and crawl up and attach themselves to a blade of grass near the water's edge, losing their tail then and remaining quiescent until swallowed by some unlucky sheep which comes down to drink. Once arrived at the height of its ambition inside the sheep's liver, the fluke commences in real earnest and sets up irritation and a distending of the biliary ducts, with dire results. Although the sheep does not appear to be affected much at first, and may indeed for a short time even put on flesh, the final stage is loss of appetite, debilitation and death. Sometimes they get over it, on the eventual departure of the fluke organism, but they are never the same again.

Remedial measures consist in keeping sheep as much as possible on *dry* uplands. It should always be remembered that the sheep as a domestic animal has been obtained by selective breeds from a wild type, like a goat, whose natural place was among the sparse dry herbage on the tops of the mountains. Sheep will be generally better if reared under conditions that more nearly approach the natural environment than on low-lying ground, which tends to produce foot-rot in addition, although we have a strain, the Romney Marsh breed, which would seem to have become inured to conditions on soft ground.

I should have mentioned in the case of the acarus tick that the habit of this creature of falling off for moulting and egg-laying purposes to return to sucking on some other animal brings in another complication, viz. the transmit-

ting of disease viruses from one to the other. This is seen particularly in the case of Redwater in calves ; where the Ticks, by sucking affected beasts and passing to others, are a considerable danger. The redwater disease however is not transmissible to *sheep*, and so advantage can be taken of this fact to run sheep on ground where it has occurred, to attract the Ticks, which are then disposed of in the dip.

Pigs are not worried with insects to any extent. Their troubles are mostly confined to swine fever, anthrax, and erysipelas, whilst foot and mouth disease, if it occurs amongst pigs, may be the precursor of a serious outbreak among cattle. These however, as already stated, are beyond the scope of this book, although I shall have to refer to Tapeworms in a later chapter.

If I were to attempt to deal with all the insects round, in and about a farm, this chapter might well be extended to ten times its present length, but we shall have to conclude this livestock section with a brief reference to poultry parasites. Amongst insects the birds are attacked by Fleas (*Pulicidæ*) and Lice (*Mallophaga*), but there are also Mites (*Acarina*). A specimen is shown of each kind of parasite. As has been mentioned in Chapter I, dirt is the friend and cleanliness the enemy of all these creatures, but an additional deterrent will be found by adding pyrethrum powder to their litter or in the nests. Fowls rid themselves naturally by means of the dust bath.

There are in addition internal parasites of poultry, in the form of nematoide or round-worms, which cause gapes and intestinal troubles. The Gape-worm (*Syngamus trachealis*) attaches itself by the circular mouths to the interior of the bird's windpipe, sucking its blood and causing much pain, which may often end fatally, especially in young chicks. Cleansing roosts, nests and runs with hot lime wash should be resorted to as soon as gapes is suspected. Affected birds to be isolated and a brush of turpentine passed up and down their throats. The birds cough up the worms when they become mature, and thus

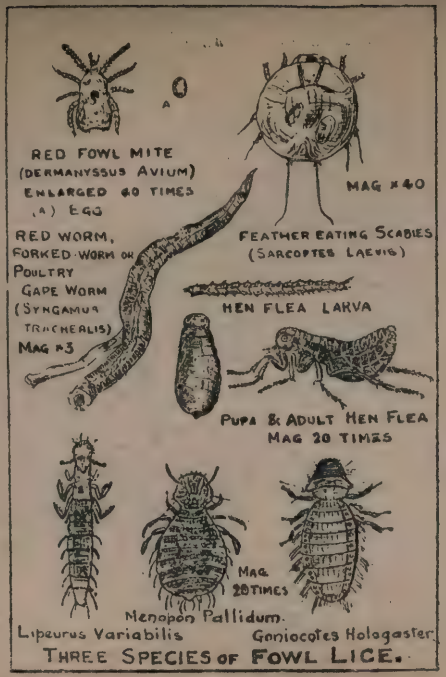

PLATE 6.
Poultry Parasites.

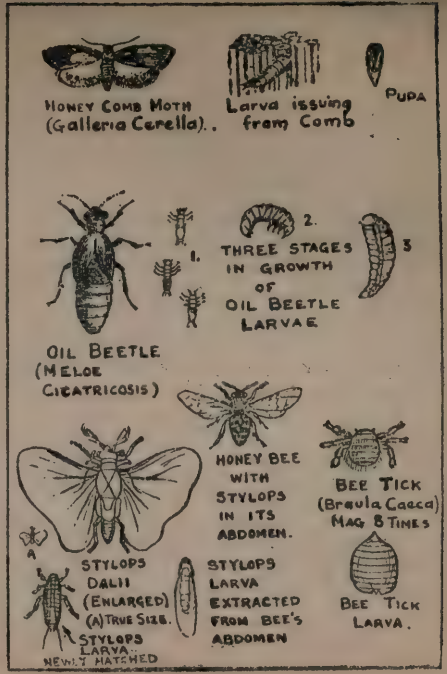

PLATE 7.
Bee Pests.

in aneglected run the danger of infection of healthy birds is increased, as either the worms or their eggs may be picked up. (See Plate 6.)

Intestinal worms of the genus Heterakis also occur, and cause birds to become ravenous about their food whilst still suffering loss of condition. The full development of the intestinal worm takes place within the fowl, and it may be expelled by a dose of Thymol in the form of one grain in a dough pill morning and night.

Bees are a special study in themselves, and subject in their turn to numbers of parasites and disorders, chief among them being the dreaded Isle of Wight disease, and the Foul Brood or Bee Pest. Then come insects proper, which it is our purpose here to examine. These consist of those which prey on the hive and the young, and those which attack the bees themselves. Of the former there is the Honey-comb Moth (*Galleria cerella*), a dull brown coloured insect measuring about an inch across the wings, and whose larva lives upon the wax of the cells, so spoiling the comb. A drawing is shown of both moth and larva. The same kind of damage is done by the larva of the Oil Beetle (*Melöe cicatricosis*), but this insect also devours the bee's egg and afterwards feeds upon the bee-bread prepared by the unsuspecting hive-dwellers for their young ones. Remedial measures consist mainly of removing and destroying these insects during their larval state, and all bee-keepers watching for them before they get the upper hand. (See page 57.)

The bees themselves have in addition body parasites in their mature state, a minute coleopterous insect whose larva establishes itself between the segments of the bee's abdomen in the manner shown in the sketch. The insect itself (*Stylops dalii*) is of the form indicated in the larger drawing, an extracted larva being also represented. These parasites were formerly supposed to belong to a special order of their own, called the Strepsiptera, or Twisted-

Wings, which is a very good description. Fortunately they are more curious than harmful. I also give a drawing of the Bee-louse (*Braula cæca*) which lives among the hair of the thorax of queens and drones. It is the only species of its kind. (See Plate 7.)

The Foul-Brood, or Bee-Pest, which kills the young bees in their cells, is caused by a bacterial disease among the larvæ and pupæ, known to science as *Bacillus pluton*, and its presence is indicated by a characteristic gluey smell. The larvæ appear yellow or transparent instead of the glistening white of the healthy ones. All infected sections and hives should be charred over with a painter's lamp and be scrupulously cleaned.

The dreaded Isle of Wight disease is caused by a microscopic animal parasite, a protozoon called *Nosema apis*. It carries out its life-cycle within the bee itself, causing them to sicken off and die. Here again the most scrupulous cleanliness both in and about the hive, and particularly of the drinking water, will lessen the chances of infection. Where a colony has to be cleared off, it should be burnt, so that the disease may not be transmitted to other hives; strong liquid ammonia will put the bees to a merciful end in the first instance. The diseased hive should also be charred over inside for the same reason. Various drugs have been tried as preventives and cure of the Isle of Wight disease, the bees taking it in their candy, but an absolute specific has not yet been found. Recently sprays of oxygenated water have been tried with some success, but the best treatment of all to my mind is to place the hives in such a position that they will get the maximum amount of light, particularly sunshine, which contain the health-giving rays that will enable the bees to resist the disease in the first onset.

We now pass from live-stock (and hive-stock) to field crops. Here I shall take one outstanding example in some detail, viz, that of the Turnip Moth, as showing in what way the pest nuisance comes about. We will,

however, take the crops more or less in their order.

With CLOVER we find our first uninvited guest in the shape of a weevil. Throughout the whole of our study of pests we shall find that these small beetles are with us, both in and out of doors, in some form or other even to the last. In fact, weevils, to which I shall have to recur so many times, are not to be put off in any way. Their enterprise and persistence is an excellent example to the grower and the farmer alike.

The Clover Weevils, of which there are more than one species, attack all kinds of leguminous crops, the insect shown, sometimes called the Striped Bean and Pea Weevil (*Sitones lineatus*) being the commonest. It measures about $\frac{1}{4}$ inch in length, and is greenish-grey in colour, the thorax being often striped with light and dark shades. Both beetles and their maggots are harmful, the latter feeding on the roots of the plants. The eggs are laid in early spring close to the roots of the crop by the adult females which have been hibernating throughout the winter months in litter around corn and haystacks and other odd nooks and corners. These produce small white maggots, root-feeders throughout May and June, eventually becoming the summer brood of weevils. These insects may be effectually checked by a rigorous and constant collection of litter and likely wild herbage in the shape of vetches and other weeds.

CLOVER is also subject to attack from Eelworms, a minute animal, allied to the intestinal worms, known as *Tylenchus devastatrix*, which feeds within the tissues of the plant, and is the cause of one of the forms of clover sickness, and it passes to and from several crops. (*See* remarks on field strawberries in Chapter IV.) Eelworms also attack oats, onions, daffodils, hyacinths and other garden plants. Where the ground is infested with them it should be gas-limed.

GRASS LAND, as we might suppose, is at times subject to severe attacks from insects, principally moths and

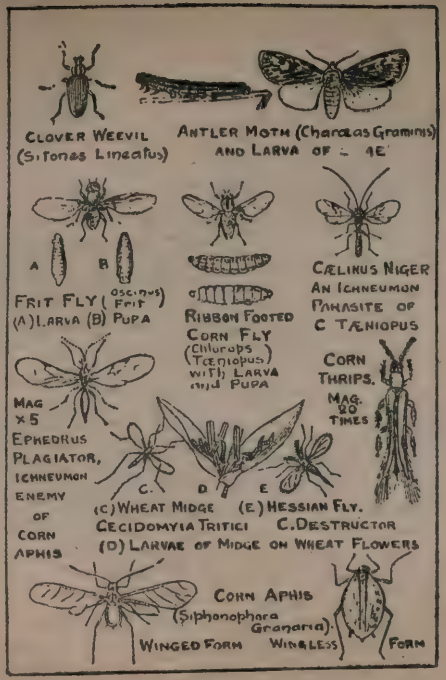

PLATE 8.
Insects that Infest Corn and Grass.

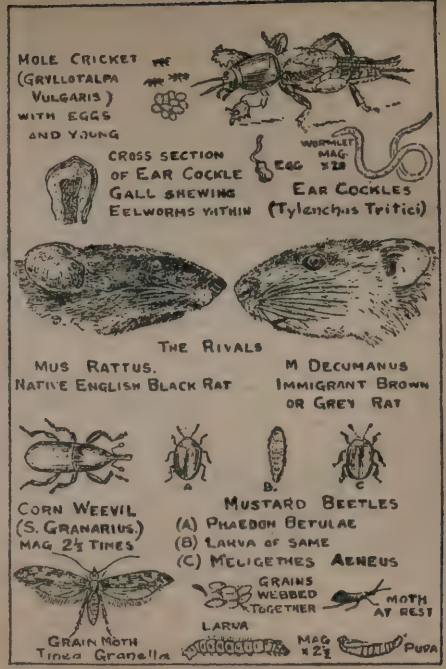

PLATE 9.
Grain Eaters, etc.

beetles, and these divide themselves at once into those which feed on the leaves of the grass and those which carry on their destructive work among the roots in the soil. In the first category are the larvæ of many butterflies and moths, among them the whole series of our pretty Meadow Browns, Ringlets, Heaths, Speckled Woods and Graylings, but these are all harmless, and in the winged state may even act as a set-off against the preponderance of the Cabbage Butterflies. Then there are moths, such as the Drinker, the Common Wainscot, the Flounced and Square-spot Rustics, and the pretty little Yellow Shell which starts up as one passes along the field and hides itself in the blackberry bush. All of these are grass feeders, but generally innocuous.

Then we come to those insects which devour the roots, and here we must be more discriminating. Among beetles there are the dreaded Wireworm and Cockchafer, also the Crane Fly, but these I shall deal with under the head of Soil Pests. Among moths we have the Light and Dark Arches, the Ear and the Antler Moths. We need hardly trouble about the root-feeding of either of the first three, as the depredations of the last overwhelm them all.

The Antler Moth is not merely known, but feared, on the Continent, and even in this country whole acres of pasture have been destroyed by the unseen activities of this quiet, brown-winged insect, which damage may often be attributed to that done by the Wireworms mentioned above. The advent of this moth is looked upon, as I said, with terror in European countries, particularly in Sweden, and it comes with great suddenness, not in droves, nor in battalions, but in whole armies, advancing almost by routine, from field to field and slope to slope, yet out of sight, destroying as it goes, leaving a shrivelled, parched wilderness behind it. A case observed in England many years ago in the

neighbourhood of Keswick illustrates the mode of procedure, where a level patch on the summit of Skiddaw could be seen even from the town assuming a burnt-up appearance. This was found to be the work of the Antler Moth, and the progress of the caterpillars could be marked off from day to day, in addition to which vast numbers of rooks followed them down as they advanced. What are we to do with a case like that? Of course it should be remembered that although Nature is often quite ruthless about taking away, as a rule she unsparingly gives back again *eventually*. In the present instance the moth, which emerges at the end of August, is somewhat erratic in its movements and likely to migrate to another locality, whilst the devastated pastures will grow again all the richer for its visitation. This may be thought a poor consolation for the farmer or grazier who has to depend upon his annual crop, but a knowledge of these broad principles will prevent the wasting of precious time and money on merely palliative efforts or quack remedies. The rook is the farmer's best friend for soil insects, and works for nothing, and it should therefore be allowed to stand as the natural enemy of the Antler Moth. Wherever it is possible to open the ground its useful work may be facilitated, and then followed by the use of lime and the exposure of the newly-turned sods to alternate frost and wet, which is fatal to moth pupæ.

Our next subject is CORN, where several insect troubles await us. First there is the Frit Fly (*Oscinus frit*) a minute dipterous insect which is the cause of loss chiefly in oats, but also with wheat, barley and other cereals. This fly is only $\frac{1}{10}$ inch long, shining black with yellow legs. The maggots, about the same length, are narrow at the head and provided with mouth-hooks by which they mine their way into the heart of the plants. This larva pupates within the plant itself and the first brood hatches out in the month of April. The important thing is to get the oats either winter-sown or

in the ground before the end of March, stimulating the growth so as to resist attack, as it has been shown that the flies are attracted first by the tender green shoots. In fact they will lay their eggs on grasses if the corn is too far advanced or is mown. There are a succession of broods in the year, the last being in September, when the flies are obliged to raise their last brood on wild grasses. The symptoms of Frit Fly trouble are shown by pale spots on the green leaves, which then become reddened or withered, and there may be a stunting or failure of the whole plant. In July, if the fly is established, the summer brood will attack the grain itself, particularly in northern latitudes where ripening is protracted. A badly infected crop must be ploughed in deeply, choosing, by examination of the plants, the time when the maggots are mostly half-grown, as this will cut off the whole generation when there is no chance of its continuance.

Our next example is the Ribbon-footed Corn Fly or Gout Fly (*Chlorops tæniopus*), which is very injurious in some seasons to wheat and barley. The insect appears in May and June, laying eggs on the spathes or sheath of the young ear. The maggot then passes down the stem below the ear and feeds at the base of the first joint, changing to a brown, cylindrical pupa in July, the second brood of flies appearing within a month. This brood passes the winter within the corn plants, to hatch out the following spring. The treatment consists of winter or early spring sowing, as in the last instance, and keeping down couch grass, which is an alternative food plant. In addition, all refuse from an infected field should at threshing time be burnt, and it is also advisable to remove the next crop as far as possible from the site occupied by the present one. The Ribbon-footed Corn Fly has a natural enemy in the shape of a pretty little ichneumon fly named *Cœlinius niger*. This diminutive, dainty insect is about ¼ inch long with flowing antennæ

and glittering, glassy wings. A sketch of it has been included among the Hymenoptera in the last chapter. It lays an egg in the Corn Fly Maggot's body, and its larva feeds upon and finally destroys its host, thus performing a most useful service. (See Plate 3.)

We now come to the Hessian Fly (*Cecidomyia destructor*) which attacks wheat, barley and rye, the wild foods being couch and timothy grass. In all these cases we shall find that there is a wild alternative food plant, and should therefore time our weed offensive at the most awkward period for the pest, say just when the eggs are hatching, and again when the larvæ are half-grown. The Hessian Fly, although only $\frac{1}{10}$ inch long, is a cousin of the Crane Fly or Daddy-long-legs, thus showing that size is no criterion as to relationship in the insect world. It is dark in colour, with reddish abdomen, and black or smoke-coloured wings. The eggs, which are red and glossy, are laid in the furrows of the top surface of the leaf-blade, and the maggots, which are legless, yellow in colour, feed between the leaf-stem and the blade. The plants thus become weakened from loss of sap, the stems being often "elbowed." The full-grown maggots pupate where they feed, and the white pupæ are enclosed in a reddish-brown case, which may be seen sticking out at the leaf-joints and are then known as "flax-seeds." It will be necessary to burn straw where a bad case of Hessian Fly has occurred. The crop that follows should be clover, on which Hessian Fly cannot feed. This insect as a matter of fact has not given much trouble in England of late years, but is always likely to turn up in full force.

The Wheat Midge (*Cecidomyia tritici*) is closely allied to the last insect, and similar in appearance, being if anything more injurious. A drawing is shown to illustrate the difference between the two. It will be seen that the wings of the Hessian Fly are hairy and smoke-coloured, whilst those of the Wheat Midge are clear and

smooth. The same measures should be adopted for either. The Wheat Midge confines its operations to the wheat flowers only.

Wheat, as might be expected, is subject to the careful attentions of many insects besides those already described. There is, for instance, the Mole Cricket (*Gryllotalpa vulgaris*), belonging to the Orthoptera, and which is one of our largest insects in this country. It is more than two inches in length when full grown, and it leads a subterranean life, tunnelling about, by means of its powerful fore-legs, in the soil at the roots of plants.

Mole Crickets like sandy soil best, and they are not strictly limited to a vegetarian diet, feeding to a considerable extent upon other insects and worms, but in the carrying out of their "earthworks" they make no bones about gnawing through any roots that impede their progress. The sexes pair in the middle of June, about 350 eggs being laid in a neat little smooth round cell, connected with the surface by means of a curved gallery. Contrary to the general rule of insects, the mother cricket lives on to nurse up her offspring, which she does with great care. Not to spoil her children with too much attention, however, Mrs. Mole-Cricket is in the habit of eating numbers of them from time to time. In fact, the rule in their household is, "Just behave yourself, or mother will eat you." This odd propensity curbs the undue increase in their numbers, or there might be dire results. The young mole crickets are just like small black ants at first, and feed voraciously on the tender rootlets of the wheat. They have a natural enemy, too, as well as the unnatural one above described, in our little furry friend, the Mole himself, who is said to be very fond of them, quite as fond, indeed, as if he were their own mother! With regard to natural deterrents, it has been found that a very slight dressing of paraffin and ashes will drive them away, as these Crickets have a keen sense of smell, and paraffin is particularly abhorrent to them. (See Plate 9.)

Then there is the Corn Thrips (*Thrips cerealium*), one of the Thysanoptera, or Tassel-wings, a sub-order allied to the Aphides. The Corn Thrips is not more than one-tenth of an inch long, black and brown in colour. These insects get right in among the grain in the ear, feeding on its soft juices after the manner of an aphis. All weeds should be severely kept down, as they afford the Thrips house room and support after the corn has been reaped and during the winter months. (See Plate 8.)

The same remarks apply to the Corn Aphis (*Siphonophora granaria*), a sketch of which is shown giving both the winged and wingless forms. These insects breed profusely throughout the summer months and hide up on broom, furze and ground weeds during the cold weather. We shall find Aphids or Plant Lice turning up so many times in the course of this book that it will not be necessary to go further into their study here. (See Plate 8.)

Among Lepidoptera the notorious Turnip Moth is also known to feed upon wheat roots, but I shall deal with that insect shortly, when we can examine its economy in detail. The Grain Moth (*Tinea granella*), does a good deal of damage in the barn. It is a little dusky white insect with brown spots, which spins a web to bind the grains together, feeding on the starch therein. The same kind of damage is done by the Corn Weevil (*Sitophilus granarius*), only more so. The weevils are responsible for much loss. Their larvæ bore into the grain and so destroy its value. Both Moths and Beetles retire, on reaching maturity, to the corners and any dusty hiding-places in the granary that they can find. Hence scrupulous cleanliness is the best means of destroying these pests. (See Plate 9.)

Ear-cockles of Wheat is caused by an internal parasite, of the eelworm tribe, which is so injurious to Clover and other crops. They belong to the same order, the Nematoidea, as the intestinal worms of animals, birds and fishes. The Ear-cockles cause a gall to form on the

wheat, and when the ear ripens and falls to the ground the larvæ within escape into the damp soil where they live on until a fresh crop appears. They are able to live on grasses as an alternative. Various poisons have been tried, but without success, and the best remedy for a serious attack is to burn the straw, lime the soil, and follow with potatoes. (See Plate 9.)

We have now given a short account of most of the pests of Wheat, both on the field and in the barn, but it is more than likely some one will be saying that the chief enemy has, after all, been left out, viz. the rat. We are only dealing with insects here, but nevertheless the rat question is one of considerable gravity which we ought to just glance at. Numberless have been the suggestions for dealing with it, from the first Booby-trap which the artful rodents used to walk round and wink at, to the latest grandiose scheme of the American who wanted to start a ranch of a million cats, to absorb the rat population *en masse*, afterwards selling off the cats' skins in the shape of furs and muffs for the ladies!

As mentioned in our first chapter, the present rat in this country is the grey or brown variety (*Mus decumanus*), a heavy-built animal measuring 8 or 9 inches in length of body. The native English variety is *Mus rattus*, a smaller and slimmer creature, bluey-black above and of lighter colour underneath, and has recently been on the increase. Shipping is of course the means by which rats have been introduced from one country to another. Both species convey the bubonic plague.

With regard to the various schemes for rat reduction, whether they be in the shape of traps, poisons, viruses and professional catchers, these to my mind do not strike at the root of the problem, for I am a believer in natural laws and natural remedies. It seems to me that the rat question will be solved by keeping the natural balance under better control for one thing, and by making high-class rat food uncommonly scarce for another. We must not

sweep away from the countryside, but rather preserve such useful little animals as the Weasel and the Stoat, and such birds as Hawks and Barn Owls, which subsist upon rats, mice and other vermin. *Of course* they will take young chicks if they have half a chance. Moral, don't give them half a chance. Think, for instance, of the value of the Barn Owl alone. This inestimable bird, the symbol of sombre wisdom, will save a farmer a whole sack of corn in a single season, and yet it was at one time the game-keeper's chief delight to string it up on the bough of a tree along with a gruesome collection of dead bats and moles in order to show the world what smart people we are. The net result is that we have a rat question. (See Plate 9.)

The domestic ferret is an albino polecat and can only be kept in captivity, as it is unable to winter in England out of doors. It is a useful animal for rat-hunting. But most important of all, we must build our barns and granaries better, so that no rat can possibly harbour there, being thus compelled to go out into the open, to find its food or its fate as the case may be.

We will now have a look at the Mustard Beetles. These pretty insects are often very destructive with this crop. There are several species, but two of them are the principal offenders, viz. *Phaedon betulæ* and *Meligethes æneus*. The latter insect is also injurious to turnip flowers and other cruciferous plants, being known as a consequence as the Turnip and Cabbage Flower Beetle. They eat the blossoms, both as beetles and during the larval stage, sometimes migrating in droves from one field to another, larvæ and beetles working together, there being a succession of broods, from May onwards.

P. betulæ, the Mustard Beetle proper, is shining blue or bluey green in colour, and about $\frac{1}{8}$ inch long. Its larva is also shown in the sketch, and when full-grown is nearly $\frac{1}{4}$ inch long, rather hairy, dull yellow or smoky grey, spotted with black, whilst the head also is black.

M. æneus is often found on mustard in company with the last-mentioned insect, and does similar damage, eating the flowers and so reducing the yield of seed. It is only one-twelfth of an inch long, varying in colour from black to dark green or violet, with a brassy gloss, quite a neat little thing. The larva is yellowish white or pale grey. (See Plate 9.)

Both beetles lay their eggs on the opening buds, on which the larvæ feeds, afterwards dropping on to the soil to pupate.

The best treatment consists in beating or shaking out the adults into vessels containing paraffin, although equally good work can be done by boys with butterfly nets, shaking the flower-heads free of beetles; the nets, when a quantity of beetles has thus been obtained, being shaken into boiling water. The nets may be used wet, as this prevents the insects from crawling out.

In badly infested fields it is, however, desirable to plough in the whole crop deeply, so as to bury the eggs before they can come to maturity. The eggs are yellow, like the flowers, and as a consequence difficult to see.

We must now turn our attention to field root-crop pests. Turnips and Swedes will answer this purpose, the Beet and Mangold pests I shall deal with in the next chapter. Turnips and Swedes seem to be the special quarry of destructive insects, almost as much so as the cabbages of the kitchen garden. We have once more both beetles and moths, to which must however be added aphides, saw-flies, and two-wing flies. Turnips suffer the most as a rule, and it has even been noticed that where a bad attack on this crop has occurred, swedes are more resistant, if not altogether immune, although growing close by.

The damage done to turnips and swedes by aphids and two-wing flies is almost negligible compared with the other three types of insects mentioned, and their consideration may be left to be dealt with under other

headings. The first serious pest is the Turnip Saw-fly (*Athalia spinarum*). This is a small brown insect related to the Wasp tribe, and measuring about ¾ inch across the wings. The damage done consists solely in the voracious habits of the larvæ or "niggers," which may be instantly known by their dark colour, numerous legs and curious habit of curling themselves about in various attitudes as they feed. They are barely an inch long when full-grown. The final stage takes place in the soil, the white pupa being enclosed within a brown pupa-case. Eggs are laid by the females during May and June. They make small incisions in the soft parts of the leaf by means of their saw-like weapons, and one egg is placed in each slit, with a drop of irritant fluid which excites the sap towards that portion of the leaf and thus affords the young saw-fly sustenance. They come out on to the surface when full-grown and appear as shown in the sketch. In a bad case the only cure is to plough in deeply when the pest is half-grown. On a small scale, however, syringing with tobacco-water is recommended. (See Plate 10.)

There are three outstanding offenders among beetles which make turnips and swedes generally their place of business and convalescent home all in one. These are, in their order of demerit, the wretched Turnip Flea or Hopper (*Phyllotreta nemorum*), the Turnip Gall Weevil (*Ceuthorhynchus pleurostigma*), and the Turnip Mud Beetle (*Helophorus rugosus*). The first two divide their attentions amongst the various cruciform plants, and the third confines itself to the turnip only. I shall have to deal with the Turnip Gall Weevil under cabbage pests in the next chapter, as it is responsible for the kind of injury wrongly called club root, so we will take the Flea here and see how best we may induce him to "hop it."

This insect is barely an eighth of an inch long, blue-black or green-black in colour, and it causes immense injury in some years by eating off the seed leaves as soon

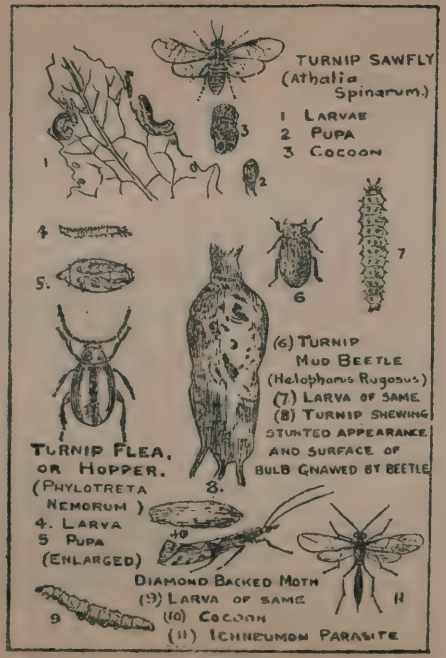

Plate 10.
Turnip Troubles.

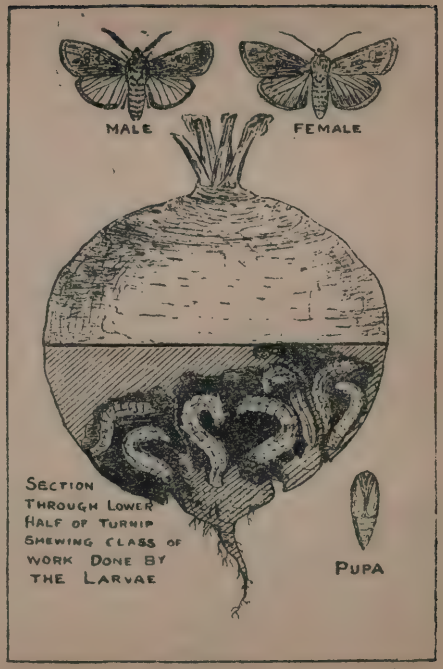

Plate 11.
The Notorious Turnip Moth.

as they appear. They prefer dry weather and dusty soil, so that showery conditions are a double protection, hurrying the turnips on past the critical period and also discouraging the pest. The adult insects, as happens in so many instances with beetles, pass the winter under clods of soil, where they lay in wait for the first green leaves to destroy them. They also hide in old turf, tufts of grass, and rubbish in hedgerows, living upon wild radish, charlock and other weeds until the turnips come up. They then lay eggs upon the second, or rough, pair of leaves, where the yellow larvæ mine about in the tissues, pupating in the ground when full-fed. In a short time (less than a month) the complete cycle is perfected, and so there may be as many as six broods in a season, which accounts for their vast numbers. Both beetles and larvæ gnaw the plants.

Seed soaked in paraffin acts as a deterrent, whilst every care should be taken to keep down weeds, and clear away rubbish and litter. The drills should be well rolled when the seed is in, as this will break down the clods and get rid of hiding-places for the pest. An ingenious check consists in drawing over the ground a light framework on wheels, of boards with the underside tarred, the height above the soil being just sufficient to pass immediately above the plants. In this way the beetles, being startled, fly upwards and are caught on the wet tar, whence they can be scraped off and the tar renewed. (See Plate 10.)

The Turnip Mud Beetle has quite different habits. Both beetle and larva work together however, and they gnaw the surface of the bulb about in such a way that rain and fungi are able to enter and so destroy the plant. The leaves and stalks are also eaten. The adult is about ¼ inch long, dark red really, but as a rule covered with mud. The larva is spotted and light brown. They breed throughout the season. A stimulating dressing is the best means of prevention, so as to hurry the crop on

to the resistant stage, and the next lot of turnips should be sown at a distance from the site of the previous one.

Last, but by no means least, there are the moths, of which two, a very small and a fairly large one, will suffice.

The dainty little Diamond Back Moth (*Plutella maculipennis*) has sometimes been a source of anxiety to the farmer with regard to the turnip crop, and its hordes of caterpillars have been known to devastate whole fields of cabbage, rape and swedes. The insect is about ½ inch long, light brown in colour, with the three white "diamonds" as shown in the sketch, and the first brood hatches out from pupæ which have wintered on charlock, hedge mustard and similar weeds. The females lay their eggs on the undersides of the leaves, and there may be two or more broods in a season. The larvæ are green and ½ inch long when full-grown. The pupa is contained within a pale yellow silken cocoon. Soot and lime dusted on the plants will check these insects, or alternatively they may be sprayed with carbolic acid and paraffin emulsion. (See Plate 10.)

The Diamond-Back Moth, however, has many natural enemies among the birds; starlings, peewits, plovers and gulls helping to keep them down. Also it has an interesting foe among the insects in the shape of a small ichneumon fly called *Limneria gracilis*. This tiny yet beautiful creature, like the rest of its kind, does, unnoticed, work of the highest value. A larva, well grown, for instance, may be feeding away unconcernedly, thinking of nothing but the food in front of it, when our dainty lady ichneumon, with glancing gossamer wings, hovers silently above, her ovipositor of needle-like sharpness "trained for action." She alights swiftly, and in a single moment has driven it straight into the caterpillar's skin, making off at once without more ado to carry on the good work elsewhere. The caterpillar may start, or twitch itself round, as at a pin-prick, and go on feeding as before, but henceforward it is doomed, for an egg was deftly

placed in the tiny wound made by the ichneumon. Before long the caterpillar will develop a "peckishness" about its food, with an appetite which it cannot satisfy, for the other larva inside it, always careful to avoid biting a vital part of its host, has to be brought on to maturity. When full-fed, the ichneumon larva destroys the moth larva and bores its way out to pupate and emerge as a perfect fly. It is thus that Nature provides the true check for the Diamond-Back Moth. We shall come across many similar cases of parasitism as we proceed, some of them hymenopterous insects like this ichneumon, some dipterous like the common house-fly. It is more than probable that every butterfly and moth is thus attended by a fateful shadow in its path, although they have not all been identified. The attack is nearly always in the larval stage, but there are actual cases of the tiny egg itself being parasitized by a still more minute hymenopterous enemy.

Our concluding example is the infamous Turnip Moth (*Agrotis segetum*), whose larva, one of the so-called "surface caterpillars," from the habit of hiding under a clod during the daytime, works such havoc. In America they have "cut-worms" of allied species, which eat around and so sever the stems of the plants attacked.

The Turnip Moth is a long-standing and vexed question in this country, and its depredations extend over quite a long range of plants, wild and cultivated. The larva will, in fact, eat anything succulent, but burrows greedily into the turnips wherever they can be found. It betrays the "cut-worm" characteristics in the flower-garden, especially among the asters, where the long-suffering gardener will be grieved to see his most prized plants unaccountably wither up and die. A glance at the stem just where it emerges from the soil will reveal the cause, for the outer rind will be completely gnawed through and the plant thus ruined. Let him surround them with a little ring of soot and alum in advance.

The moth measures about 1½ inches across the fore-wings, which are variable in both colour and markings, the prevailing scheme being greyish-brown, with several darker, ear-like spots and an indistinct dark border. The hind-wings are pearl-white in the male and pearl with a clouded border in the case of the other sex. There is a further distinction in the antennæ, those of the male being strongly ciliated or feathered, the female's being wiry and plain. In both sexes the veins of the hind-wings are picked out in black. (See Plate 11.)

Eggs are laid in June on a seedling, close to the ground. Turnips, Carrots, Mangolds, Radishes and Cabbages are all attacked. The larva is not exactly a pleasant-looking affair, pale smoke-colour slightly tinged with pink and with variable dark stripes. It is nearly two inches long when full-fed. The stem-gnawing is a youthful accomplishment. Later on it seeks out the turnips and bores right into the interior. A specimen of the class of work done is shown in the sketch. The caterpillars usually pass the winter either inside the turnips themselves, in which case they are able to feed during mild weather, or else beneath the soil in a torpid state. A few strays *may* pupate in the autumn, and hatch out as moths in the course of a few days. The females of this autumn brood, however, are usually barren, a case almost comparable to the surplus of drones in a bee-hive. The bulk of the larvæ change to a glossy brown pupa in the month of May, the moth coming out in June for the summer brood.

Now what are we to do in a case like this? Let us seek the true cause first of all, and at the expense of being tedious we must again, I think, admit that here is another instance of interference with Nature's laws. Each creature has its natural food provided for it. The Turnip Moth subsists on roots. Man grows roots on a grand scale. Nature grows Turnip Moths to a similar extent. Nature evokes a greater number of rooks, partridges and

starlings to eat these grubs. Man in his "wisdom" destroys the birds, and then wonders why he is afflicted with the Turnip Moth! Surely the remedy is plain enough? We want the turnips for ourselves. Then let Nature work out her own balance, by not interfering with but rather encouraging the birds, giving them a kindly thought and a sheaf of corn in the cold months when the soil is too hard for their beaks to penetrate. In this way we shall keep the Turnip Moth within reasonable bounds.

We must now leave farm and field in order to consider the claims of the vegetable garden, which must form the theme of my next chapter.

PLATE 12.

British Butterflies which should be preserved.

1. Small Tortoiseshell.
2. Clouded Yellow.
3. Large Skipper.
4. Small Copper.
5. Peacock.
6. Small Heath.
7. Brown Clrgus.
8. Brimstone.
9. Common Blue.
10. Wall Butterfly.
11. Meadow Brown.

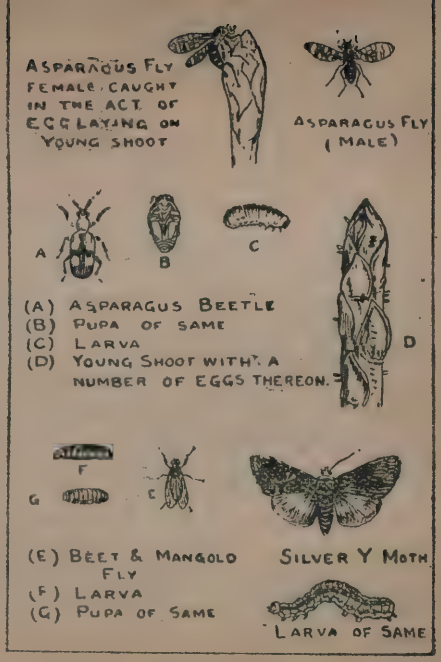

PLATE 13.

Asparagus, Beet and Mangold Pests.

CHAPTER III

GARDEN PESTS

Significance of the pest problem—Methods of Nature—Story of the Cabbage Butterflies—Other Cabbage pests—Aphides—Asparagus pests—Beet and Mangold pests—Beans and Peas—Carrot, Celery, Onion and Parsnip—Potato pests.

I NOW propose to take a round survey of the common insects that attack our ordinary garden crops, and to deal at some length with one of them for the purpose of showing what is in my opinion the real aspect of the pest problem.

As a matter of fact it is a problem of much deeper significance than the mere discovery of an easy way of getting rid of something which bothers us at the present moment. All pests and parasites are working out a definite plan which is not yet by any means fully known, although it is clear the scheme is a complicated one, even for each particular subject.

For instance, in the dispersal of mammals, including ourselves, over the various continents and islands of the globe, parasites have played a very important part, whilst species now extinct, like the mastodon, as soon as their purpose was fulfilled and they became as it were "back numbers," were got rid of in ways that no one would at first have guessed at. In fact this question of pests and parasites affords a striking instance as to how very deceiving the apparently obvious often is.

Think of the mastodon, raging in his might through

the primeval jungle. He tears up trees and flings them down like straws. He gores mighty beasts like the bear and the sabre-toothed tiger that impede his progress, and eats up whole plains of herbage. Clearly it would seem to want something pretty big to get rid of such an animal. Yet what does nature do? She accomplishes her task by the apparently negligible action of a small fly, coupled with the puny attacks of a certain biped, physically helpless in comparison, but possessed of a brain. The latter creature was determined to occupy those forests and green prairies for himself. He dug pits for the mastodon and drank his blood, he brought his family meat all the week (without coupon), he learnt to make fire and draw pictures on the wall, and he brought home to his modest little collection of wives those tiger-tooth necklaces, anklets and leopard-skins which were the favourite items of their wardrobe. So passed *elephas primigenius*, while early man was learning the rudiments of agriculture and embroidery. And all because of a fly. So you see there is something to be thankful for in the presence of pests after all. In fact we might even say that mainly because of that fly there are motor-buses in the Strand, and you can take a tenpenny fare from Walthamstow to Ealing to-day. Who is going to say that it isn't the *little* things of life that matter most?

This is the position to-day with regard to insect pests. Work is going on, often unseen and unheeded, though not always insignificant, which we ought to understand if we expect to preserve ourselves and ensure our sustenance in the future. See remarks on Warble Fly, page 24.

The methods of nature are endlessly diverse. Nothing can exhaust her infinite variety. Witness the curious history of the liverfluke in sheep, described elsewhere. Again, some of her expedients are most incredible, instances of which we may have to notice as we go on.

One case, at any rate, is worth mentioning now, that of the common Oil Beetle, which passes through quite a strange cycle ere it reaches the adult stage. The female insect appears to be altogether careless of her offspring. She drops her eggs anywhere (truly there are 7,000 or 8,000 of them), and these minute blind maggots, as soon as hatched, have only one idea to start with, viz. to cling. They manage to crawl up a buttercup and wait until a bee comes along. The creature then clutches hold of Mrs. Bee's ankle and refuses to let go until she has taken him home. Thus, before the grub is an hour or so old, and before it can even hope for anything to eat, it must go as a passenger on a comprehensive aeroplane flight with a lady whom it has never seen! Once in the hive, however, the little grub is safe, and it proceeds to despatch the young bee and live upon the careful store there laid up for another insect.

All that pests ask of us is to be allowed to live. All that we ask of them is that they should take their energies elsewhere. How are the two opposing interests to be reconciled or otherwise dealt with?

Let us take the principal item for this chapter, for I think that out of it we can gleam the ruling idea that should govern our management of all the others.

The CABBAGE BUTTERFLIES are familiar to everybody, too much so. The Large White (*Pieris brassica*) measures about 3 inches across the fore-wings, and the Small White (*P. rapæ*) varies between 1 and $1\frac{1}{2}$ inches. Both are quite distinct species, with a separate history, although so much alike, except in size. In both insects the males are characterized by the absence of the round black spots in the top corner of each fore-wing, which are always seen in the females. The general colour is black and white, but on the undersides of the wings there is a delicate powdering of apple yellow approaching to green, an effect which by the aid of a pocket lens may

be seen to be obtained by the use of pale yellow and dense black scales.

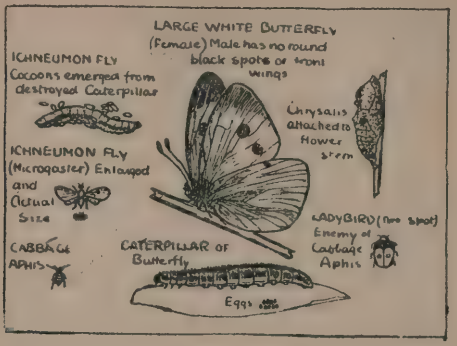

PLATE 14.

Large Cabbage White Butterfly.

The history of these insects is closely connected with that of the cabbage plants on which they now feed so voraciously.

Surely no one walking along a strip of common by the sea and noticing for the first time the little wild brassica plant would recognize in it the parent of our magnificent drumheads, savoys, kohl rabi, etc. ? We might suppose that Nature had thought about it a good deal too, and marked out the cultivated cabbage as a sort of insect paradise, judging by the riddled appearance of some of our crops.

Of course the riddled appearance spells neglect, nothing else, for those who fail to look over the leaves for butterfly eggs when the plant is young, or to use soot and salt water later, or hand-pick the caterpillars still later, will lose the majority of their cabbages.

But these mechanical methods only palliate. They do not take us any further towards settling the thing. Where then does the real cure lay ? We know, of course,

that there are at least two natural enemies of these insects, in addition to the cuckoo and other birds. One is a tiny ichneumon fly rejoicing in the enormous name of *Microgaster glomeratus*, and the other, which goes for the Small White, a dipterous species called *E. Vulgaris*, somewhat like a house-fly. Occasionally a caterpillar is seen looking very sick and sorry for itself as it creeps away into a corner. Presently we notice numbers of tiny silken yellow objects all over the empty skin of the unfortunate grub. These are the cocoons of the *microgaster* and perhaps forty or fifty will come out of one larva.

If we avoid destroying these little yellow cocoons, the friendly ichneumon will presently hold the White Butterflies in check. This little fly is Nature's censor on the undue increase of the larger insect. In it we have a very real cure for this pest, just as the plagiator fly shown on Plate 8 keeps down the Corn Aphis, so much so that naturalists have talked about the Large Cabbage White one day becoming a scarce butterfly. Certainly without the tiny ichneumon, cabbage crops would have been unmanageable long ere this.

The Small White Cabbage Butterfly is also attacked by *H. Fulvipes*, a light-coloured ichneumon with yellow legs and glassy wings measuring about $\frac{1}{8}$ inch across.

The grower will do well to familiarize himself with the general form of these useful flies. All these strong-looking, black, black and red, or bright-coloured insects should be left to carry on their beneficial work unmolested. (See Plate 3, Fig. 6, for the usual outline of an ichneumon.)

The CABBAGE TRIBE, as I said, are subject to numerous pests in addition to the butterflies. Another bad one is the Cabbage Moth (*Mamestra brassica*) whose larva eats into the very heart of the plant. This insect measures about $1\frac{1}{2}$ inches across the fore-wings, which are dark smoky grey in colour, mottled over with sepia

marblings, the hind wings being smoky brown, paler at the base where they join the thorax, and having the veins picked out in dark lines. The egg is laid on the underside of the leaves and soon hatches into a brownish yellow, unpleasant-looking caterpillar which has a habit of cocking up its head and tail when disturbed. There does not seem to be any sure method of diverting its activities. The true food of the Cabbage Moth is dock, goosefoot and several other weeds, and it may be that these native plants have become stunted down and

PLATE 14A.
Small Cabbage Butterfly, etc.

changed by agriculture's demands and so the Cabbage Moth comes to the larger feast at our expense. It is an insect which is well able to accommodate itself to a varied diet, but unless we can find a way of making our cabbage and kale distasteful to it, we must resort to armed offensive, for this tiresome creature is wasteful as well, and spoils far more than it eats. As a Noctuid or night-flying moth the perfect insect is not so much in evidence. The eggs should, however, be sought for at the beginning of the summer season, and later the larvæ may be washed out with weak salt and water, or lime-water. In the course of its growth this larva undergoes

the customary changes that apply to all lepidoptera and moults its skin periodically. (See Plate 14B.)

The Cabbage Moth has its ichneumon parasite in *P. Fumata*, a fly not more than $\frac{1}{8}$ inch across the wings with black body and red legs.

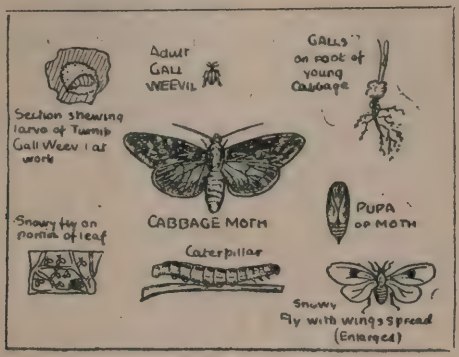

PLATE 14B.

Cabbage Moth and Snowy Fly, etc.

The pupa of this moth is glossy brown, about $\frac{1}{2}$ inch long, and it is found in the soil during the autumn and winter. If the ground be opened they may often be exposed in hundreds, and every domestic bird, from a bantam to a peacock, will gobble them up with avidity. If a field is badly infested, it should afterwards be gas-limed in winter, but ordinarily the constant opening up of the soil should be sufficient. As regards the action of frost, this is only fatal to insects that have first become sodden with water. No amount of dry frost will kill pupæ or hibernating insects. This is a little detail that is not often realized, so that the working of the soil must be done several times at favourable opportunities.

The Turnip Gall Weevil (*C. pleurostigma*) also attacks cabbage plants and causes what is known as false club. This weevil belongs to the genus Rhynchopora and is only $\frac{1}{8}$ inch in length. The female pierces the outer skin of the

stalk with her sharp ovipositor and causes a swelling, which increases in size as the larva grows, and it thus obtains board and lodging combined. The period of growth is about four weeks.

Birds are the natural enemies of the Turnip Gall Weevil, including the jackdaw, chaffinch, starling and magpie, which do good work in picking off the adult insects. In a badly infested field however, whether it be cabbages or turnips, the crop, which is not be-fouled so much as stunted by their presence, should be consumed as soon as possible, and stalks and waste should at once be burned. The next crop should be grown as far as possible away from the infested site. (See Plate 14B.)

Cabbage Root Fly (*C. brassica*) is a more serious matter. This is a dipterous greyish insect a little smaller than a house-fly. The attack takes place when the plants are quite young, just as we have flattered ourselves we have got rid of the club nuisance. The eggs are laid in April and May just above the surface and for this reason felt discs are good, placed around the roots and resting on the soil. The maggots, being blind and weak, are incapable of crawling over and under the disc to get at their work, and so die. Carbolic acid emulsion as a soil spray is also used. The natural enemies of the Cabbage Root Fly in addition again to birds, are found among the Rove Beetles, two or three kinds of which destroy this insect. They are shining black in colour. *A. fuscipes* is the largest of them. (See Plate 14A.)

Aphides also attack cabbage. I shall have something to say about them later.

The Snowy Fly, or Cabbage Powdered Wing, is a minute moth-like creature. Several are shown in the sketch on the underside of the leaf, where they make their appearance as white blight and their tiny larvæ suck the juices of the plant. The insect breeds *in situ* all the year, principally in the summer, and can be prevented by the use of the soap and quassia spray. Where it has gained

a hold all infested leaves should be burned. Soot may also be dusted on the outside leaves. (See Plate 14B.)

Asparagus. The king of vegetables is liable to attack mainly from two insects, the Asparagus Beetle and the Asparagus Fly. The Beetle (*C. asparagi*) is yellow and black in colour, with the markings of a cross on the wing-cases, whence it is sometimes called the cross-bearer. Eggs are laid in June on the heads and shoots, and later upon the feathery foliage. There are several broods in a season, according to the weather, heat of course causing them to breed more rapidly. The larvæ eat into and disfigure the heads as they come up, both beetle and larvæ also gnawing the stems and devouring the round green seeds, leaving a sticky brown mess all over the plants. During the winter the beetles go to sleep under stones and in rubbish, particularly old turf, the cosy refuge of so many thousands of small insects in the cold weather. Infested heads should be burned, and the beds dusted with powdered lime. Ladybirds and Lacewing Flies devour large numbers of these larvæ, whilst poultry and ducks will also readily consume them and are not harmful to the asparagus foliage. Again, hand picking, if tedious, is at least effective. (See Plate 13.)

The Asparagus Fly (*P. poeciloptera*) is glossy brown in appearance, the wings having waved markings of the same colour. They emerge out of the ground from April onwards until the middle of July and lay their eggs beneath the scales of the new heads, the maggots afterwards boring into the plant and working downwards. Small wooden rods coated with a mixture of tar and cartgrease will trap the flies in considerable numbers and keep the pest within bounds. (See Plate 13.)

Beet and Mangold Pests. These crops are subject to the attack of a common day-flying moth known as the Silver Y (*P. gamma*) from a conspicuous mark on each fore-wing like the Greek letter γ. The eggs are laid, as is the case with most moths, on the under side of the leaf,

in June, and the larvæ eat into the succulent parts at the crown of the root. No better plan exists than egg search, at any rate for small-holders, as although it needs sharp eyes (a chance for the children) the destruction of a batch of fifty to seventy-five eggs at a time is more than worth the trouble of finding them, and of course practice makes perfect. The ova need simply be crushed between the finger and thumb. These larvæ feed at night and must be sought with a lantern, so that there is all the more reason for emphasizing egg search. Pupæ remain in the soil during the cold season, and if poultry are run on to the ground when freshly turned up they will perform the double service of feeding themselves and ridding the soil of the Silver Y. (See Plate 13.)

The Beet Fly (*P. betæ*) lays its eggs on the stalks of leaves, the maggots forming burrows in the tissues, thus weakening and exhausting the plant. It is dark grey in colour with black hairs, the wings being transparent. Two broods occur each year, pupæ remaining in the soil until the spring. Dandelion, docks, thistles and such weeds harbour these flies and enable them to exist till the crop comes along, wherefore they should be kept out of the immediate neighbourhood. In a badly affected field the plants must be pulled up and destroyed, to prevent the occurrence of a second brood. (See Plate 13.)

Beans and Peas. Here we have first of all the small beetles and weevils which find a happy home amongst all leguminous crops. They are blackish brown in colour, and after pairing in June lay their eggs on the young pods, even making their way into the blossom itself for this purpose. Out of each egg comes a white maggot which feeds within the bean or pea and emerges the following season as a beetle. The affected seeds can be discovered by the water test, as they will float, the sound ones sinking to the bottom. Buoyant seeds should not be sown. (See Plate 15.)

Another bean pest is Thrips (*F. robusta*), sometimes

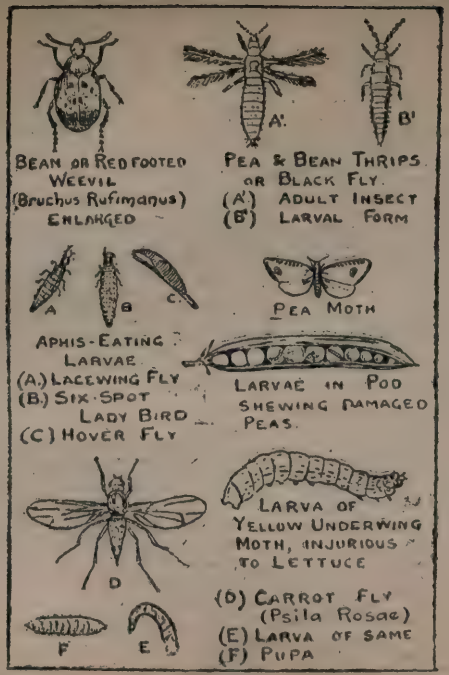

PLATE 15.
Bean, Pea, Lettuce and Carrot Pests.

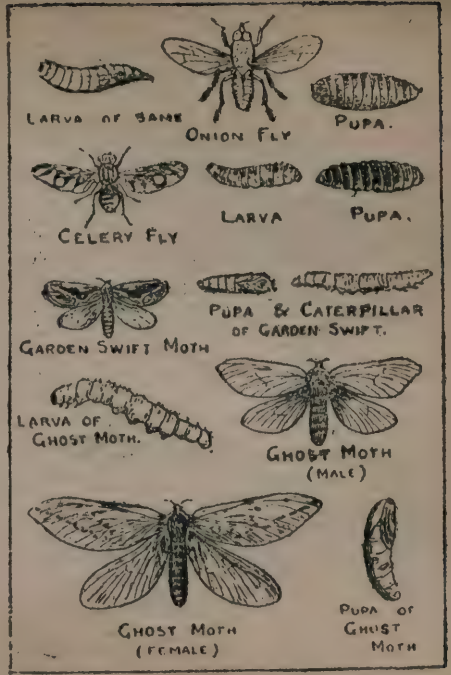

PLATE 16.
Onion, Celery and Parsnip Pests.

called Black or Thunder Fly. They are less than $\frac{1}{10}$ inch in length ; an enlarged drawing of the adult insect is seen on Plate 15.

The eggs are laid in June, and hatch out into a larva which is very similar in appearance to its parent but without the wings. They are active on the plants for about four weeks, subsequently passing into the earth to pupate, and emerge the following season as full-grown thrips. The damage done by these insects consists of maiming the flowers and often preventing fertilization altogether. The soil is the best place in which to meet them, ploughing deep and liming in the winter. On small areas some such soil fumigant as napthalene may be used effectively, but the burning of the haulm is not of much avail for thrips as they have usually left before the plants are up. Change of site will of course happen in any case.

We now come to the APHIS (*A. rumicis*). Plant lice are the most common form of blight and are met with all over the country. Each plant has as a rule its own particular species. On Plate 1, Figs. 17 and 18, will be seen the Black or Bean Aphis and also the Rose Aphis, which represent the general form of these Hemipterous insects.

The female Aphis passes the winter on furze clumps, where she deposits eggs, which produce winged individuals. These proceed to the scene of action as soon as the warm weather comes.

I always find there is a weird suddenness in the appearance of Mrs. Aphis, against which it is well to be prepared by getting emulsions and sprays in working order long before the usual time. Every spring there is that psychological moment when there is not the slightest indication of anything untoward likely to happen. You are absolutely charmed, on some warm, still evening, with the limpid air suggestive of a vesper bell. Mrs. Aphis ? Good heavens, there is no such person. You are all right this year at any rate.

Beware of that warm, still evening, in spite of the vesper bell. In other words, "trust her not, she's fooling thee." You will find she has come like a thief in the night, and afterwards you may get out your quassia or petroleum and spray well, spray thoroughly, indefatigably, but in vain.

Had you only dispersed the petroleum an evening earlier, Mrs. Aphis would have said all sorts of horrible things about you, and your coarseness and all that, but she would have gone away.

The aphides are the weakest of insects singly, but they conquer by sheer numbers and the fearful rate of increase. A thunder-storm will drown millions, but their numerical strength is up again with the first warm day. Both the winged and wingless varieties seem to be produced indiscriminately, and in some mysterious way certain females lay eggs, whilst others bring forth live young. It is advisable to pinch out the tops of the plants, as only the tender shoots are attacked. Remember that the effective time for spraying is *before* the attack, as a preventive, as described above. Weeds should not be allowed to remain in the vicinity. (See Appendix A.)

Here the larva of the Ladybird Beetle (*C. bipunctata*) does us yeoman service, spearing the aphides with its sharp mandibles and disposing of great numbers.

Ants may also be seen fondling these insects and even carrying them up and down the plant, but in this case it is of no benefit to the grower. The aphides exude a sweet fluid which ants have a great liking for. Fanciful people talk of ants keeping "cows" and refer to the fondling process as the act of "milking" them.

The aphides and weevils here treated of are also addicted to Peas, but the tiny yellowish, black-headed maggot found in the pods of our marrow-fats when they are getting ripe are the children of the Pea Moth (*G. pisana*), a delicate creature with dainty wings of a French grey colour tipped with black and measuring

about ½ inch across. They feed throughout the season and then go into the earth to spin a cocoon and emerge therefrom the following June. The pea haulm should be cleared away directly the crop is gathered and is best burnt. (See Plate 15.)

Perhaps a word or two may now be given about LETTUCE. Provided the young plants have really escaped from sparrows, there will be plenty of scope here also for green and black aphis. But of course it is largely our own fault if mischievous birds like the sparrow have our seedlings or the plants are entirely spoilt by blight.

It is always the slovenly gardener who gets crowded out with these troubles, but unfortunately he worries his more diligent neighbours with the overflow meetings of his pests, a case for supervision and penalizing.

Early dressings of soot should be applied to lettuces and renewed after wet weather. The Ladybird larva should again be hailed as a friend. Hats off to the Ladybird in fact, even though she happens to be a gentleman, for that is how things go in the insect world. Also the larva of the pretty green, golden-eyed Lacewing Fly, which is larger and dark purple in colour, is just as useful in this respect. (See Figs. A and B, Plate 15.)

Lettuces are subject also to depredations from the Yellow Underwing Moth, whose caterpillar comes and does its wretched work at night, hiding during the day under a clod or chink in the wall. It is either green or brown in colour and about 1½ inches long, with dark streaks on the back, changing in the autumn to a brown pupa in the earth. The moth is beautiful enough, the fore-wings, which measure nearly 2 inches across, being of fine ochre with darker marblings, the hind or under-wings bright yellow with the bold black margin. For treatment see remarks to the Silver Y. The scientific name is *Tryphaena pronuba*. (See Plate 3, Fig. 8, and Plate 25.)

The CARROT FLY (*Psila rosæ*) is a shining black or

dark greenish insect about ¼ inch long, which appears in spring and plays havoc in bad seasons with both carrots and parsnips. The female lays her eggs on the crown of the young root, especially favouring the time when the soil is opened out by thinning. It is believed that the scent of the carrot attracts the fly more then. Probably this is from the bruising of the roots, and it is therefore advisable to thin early and all at once, and hurry the crop, as each time it is done may bring a fresh visitation. Trenching will expose pupæ to the elements, and gas-liming in winter is also good. (See Plate 15.)

Allotment-holders in and around London had cause last year to remember the ONION FLY, as a great portion of the crop was spoiled. This is a dipterous insect, resembling a house-fly, grey in colour with brownish stripes on the thorax and nearly ½ inch across the wings. The eggs are laid either on the neck of the onion or on the soil close by. The maggots burrow down and feed on the bulb. Soil spray with paraffin emulsion and soot dressing are applied, but they must be constantly renewed after wet. Firmness of soil and earthing the onions up to the neck in the early stages are great mechanical aids. Small birds like the wren are useful as natural foes of the onion fly. The scientific name is *C. cepetorum*. (See Plate 16.)

Another small diptera is the CELERY FLY (*T. onopordinis*), a dark-winged insect measuring slightly more than the preceding example, which lays its eggs in the middle of May on the green leaves of the plant, where a swollen blister presently shows the existence of a fly maggot. These should be pinched out, care being taken not to split the leaf. If any leaves are removed they should be burnt. The pupæ in the soil should be exposed to the birds, starlings being very fond of them. Trenching is said to bury the pupæ too deep for them to find their way out again. (See Plate 16.)

As already stated, the Carrot Fly also attacks PARSNIP.

This crop however is also the prey of the Garden Swift Moth (*Hepialus lupulinus*), see Plate 16, which lays its eggs on the ground or under the leaves in the autumn and feeds throughout the winter on the root itself. This is not the Ghost Moth, which is more injurious to Hops, but its smaller cousin, and measures $1\frac{1}{4}$ inches across the fore-wings, which are of the unusual stumpy outline indicated, and are brown with whitish markings, the hind wings being smoke-coloured with a pale fringe.

The Ghost Moth gets its name from the fact that the male moth has beautiful white wings above, the undersides of which are sooty black. Hence, when flying at dusk it appears to start up suddenly from nowhere and vanish in the same mysterious way as soon as it settles on a blade of grass or the stalk of a flower.

Egg search in the first instance must be resorted to, and pieces of potato inserted in the soil near by as traps will attract the yellowish-white, brown headed caterpillar. As a natural check birds and moles devour both larvæ and pupæ of these Swift Moths, and they are also destroyed by the action of certain parasitical fungi.

We now come to POTATOES. The chief enemy of the almighty "spud" in this country is the fungoid disease for which Bordeaux mixture is used. (See pages 132 to 135.) The principal insect pests consist of the Garden Swift Moth already referred to, and the Rosy Rustic (*Hydraecia micacea*) and to a less extent the Death's Head Hawk Moth. The Rosy Rustic measures nearly 2 inches across the fore-wings, which are reddish brown in colour, crossed by a broad band of very rich dark brown. The hind wings are dingy grey, paler at the base. This moth should feed by rights on Mare's Tail. Sedge and similar coarse weeds, but readily devours the succulent potato haulm. It is simply another case of diversion from a natural to a cultivated food-plant. The eggs are laid around the stems, in which the

caterpillar feeds, and whence it must be pinched out when found. Weeds in the immediate vicinity should be cleared and burnt. Natural remedies are afforded by rooks and starlings, and the ichneumon or dipterous parasites. The pupa remains in the soil during the winter. (See Plate 17.)

The Death's Head Hawk Moth, our largest insect, measures 6 inches across the fore-wings, which are rich brown in colour, beautifully mottled and banded with deep chocolate and lighter buff tints. The hind wings are yellow with black bands, as also is the abdomen. The scientific name is *Acherontia atropos*. This caterpillar is known about the country as a "locust" and is fortunately not too common, though its depredations are soon apparent, seeing that a few of them can make quite a brave show. One elephant in a rice field may be cited as a comparison. It is almost as large as a banana, and a very curious card. When startled it utters a strange chattering cry, and the moth, which bears the ominous-looking skull mark on the top of the thorax which gives it its name, makes a noise like the squeak of a mouse, for which reasons the insect has been regarded with superstition by the fearsome, there being of course no foundation for such ideas. The huge pupa may be found in the soil at the base of trees. There is a natural enemy in the form of a large ichneumon fly measuring over an inch across the wings. (See Plate 17.)

The foregoing examples represent the principal garden pests. I thought it best to include the turnip in the preceding chapter, as although it is fairly a garden crop, still the larger sorts, as well as swedes, are perhaps rightly grouped as field crops.

The following chapter will take up quite a different aspect of the subject in dealing with Fruit Trees.

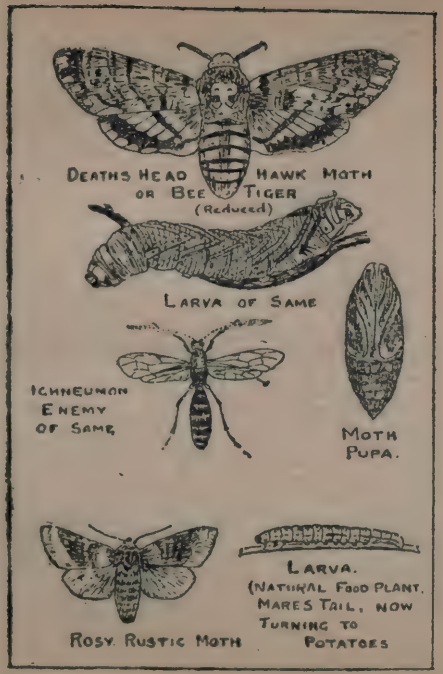

PLATE 17.
Potato Pests.

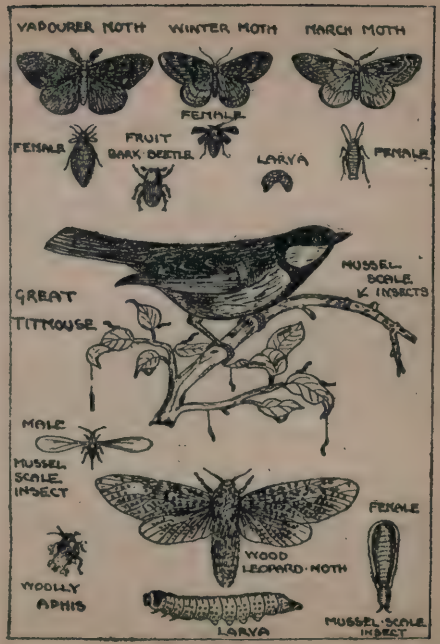

PLATE 18.
Winter Moths and other Fruit Tree Pests.

CHAPTER IV

ORCHARD PESTS

A change of scene—The innumerable tenants of trees—Apple pests—Wood Leopard Moth—Fruit Bark Beetle—Woolly Aphis—Mussel Scale—Winter Moths—Vapourer Moths—Lackey Moth—Cockchafers—Apple Blossom Weevil—Apple Sucker—Wasps—Earwigs—Codlin Moth—Apple Sawfly—Pith Moth—Plum, Pear and Cherry Pests—Pear Midge—Slugworms—Figure of Eight Moth—Bush Fruits—Raspberry Moth—Shoot and Fruit Moth—Raspberry Weevil—Currant Scale—Currant Sawfly—Currant Gall Mite—Magpie Moth—Currant Clearwing—Nut Weevil—Strawberries—Green Rose Chafer—Stem Eelworm.

AFTER the arduous "ground" work of the preceding chapters, which may have been somewhat fatiguing, it will be a good thing now to raise our eyes, straighten our backs and look aloft at the trees.

This chapter takes us around the orchard and fruit-garden, which, however well-kept they may be, have many insect troubles to cope with.

A tree is one of the glories of nature, and people who come for the first time from an arid or cold climate to a land of rich verdure like England in June, invariably use the same remark, "Oh, the trees!" And in bygone times, when the earth was warmer, and tropical splendour more widely spread, our ancestors must have revelled in the fruit on the trees long before they thought of hunting game. "Yes," says the evolutionist, with a twinkle, "we were certainly arboreal in the first instance. Witness the initial tendency of a baby to bunch itself up and

cling. The case of the small boy in the apple tree, and the expression on his face when he manages to escape, is even more convincing."

So the first house was in a tree, where were dining, drawing and bedroom all in one, and although when hard times came we had to hide in caves under the ground and shiver in a heap together while glacial storms swept away the golden age, we have never really forgotten our pristine condition, or rather the record of it is indelibly stamped into our minds, for our thoughts and feelings, bad dreams and good ones, childish fears and grown-up superstitions are all an index of something which has gone on in the past.

I suppose every one will agree that the apple is the first of fruits, the one we could least spare, all things considered. Other fruits may be fashionable or distinctive, they may even be rare and refreshing, but still the apple, to my mind, comes first.

Let us endeavour to see what a healthy apple tree ought to be free from and protected against. We need not go into the various kinds, as that lies within the province of horticultuer, and generally speaking apples are apples to insects, even though it be only a crab. Standards, bush varieties and espaliers are all liable to attack, though the modern practice of planting dwarf trees would seem to give the fruit-grower more chance of handling them effectively. Of course the fruit crop in a climate like ours, with its sudden reversions of frosty weather in late spring, must always be precarious, but that we cannot help.

A tree is like a small universe in itself, and even a modest apple may harbour a population more numerous and various than is fully realized. The inhabitants are, as we know, largely insects and mites. They may be inside the tree as wood-borers, in the bark or on it, as beetles and scale-pests, spider or moth-eggs ; or they may be leaf-rollers, leaf-miners, bud-borers, flower-eaters, fruit-

eaters or fungi. There are also stem-borers, leaf-cutters and root-eaters.

Our first example is the Wood Leopard Moth (*Zeuzera æsculi*). It is a handsome creature. It elects to be plain black and white in colour, but in living specimens I have noticed that there is a beautiful shot-blue effect about the black spots, especially when newly-hatched. The female measures about 2½ inches across the wings, and appears in the height of summer, remaining close to the tree whilst her smaller mate usually has a jaunt around the lighted lamp-posts preparatory to the celebration of their nuptials. The eggs are laid on the bark, and hatch out into a caterpillar which, as in a few other curious cases with butterflies and moths, has the same colour scheme as in the adult moth. It tunnels into the wood and there feeds throughout the winter.

This moth is, to an extent, rather maligned. Indeed we have the authority of naturalists like Edward Newman who state that the damage done is never so great as to permanently injure the tree, but that apples with this moth in them have been known to bear even better than trees unaffected.

Fruit-growers must, however, be guided by their own experience, as conditions are always changing. If a tree should be badly affected a little salt and water poured into the galleries would fetch out the larvæ or kill them, and a watch might be kept for the females during July and August. (See Plate 18.)

Coming to the bark, we have the tiny beetles of the genus Scolytus, belonging to the group of the Xylophagi or Wood-eaters. Of these the commonest is the Fruit Tree Bark Beetle (*S. rugulosus*), which affects apple, pear, plum, cherry, peach and other trees. They make tunnels in between the wood and the bark, and are more partial to sickly, decayed trees than healthy ones. The Fruit-Tree Beetle is only ⅛ inch in length and shiny black in colour, the larva legless, with yellowish head and brown

jaws. The pupa is quite white. The beetles lay their eggs in May, inside the bark, and a second brood may appear in the autumn. As to treatment, remember that *decayed* wood is greatly preferred, so that prunings should not be left about in heaps, and infested branches should be cut off and burnt. A coating of soft soap and washing-soda acts as a deterrent against the boring of these beetles. (See larva and beetle on Plate 18.)

The Woolly Aphis, Apple Root Louse, or American Blight are the names given to an aphid known to science as *Schizoneura lanigera*, which is usually abundant in old and neglected orchards where lichens and mosses have covered the trees, although it sometimes turns up in new plantations. The insect is so small even when full-grown that it may often be sent out on young stock from nurseries, and even from one country to another.

The Woolly Aphis feeds, like all its kind, by piercing the outer tissue and draining off the sap by means of its proboscis. The wound produced by Woolly Aphis sometimes serves as an aid to the growth of canker fungi. The insect is oval in shape and scarcely more than $\frac{1}{8}$ inch in length, the colour being yellow at first and then purple brown. They are both winged and wingless, and viviparous, i.e. produce their young alive. (See Plate 18.)

Natural enemies of this pest are found among the Hover Flies and the larvæ of Ladybirds; whilst the Tits, especially the Blue Tit, do a lot of good in keeping them down. (See Plates 15 and 18.)

The Mussel Scale is one of the strangest of all insects. It is frequently taken for a growth on the bark, but an examination with a pocket lens will show a dried-up object very like a mussel shell, hence the name. This is caused by a tiny creature called *Mytilaspis pomorum* belonging to the Hemiptera. The males and females differ slightly in outline and in size, the latter being about $\frac{1}{8}$ inch long. Very few people have seen the male scale as they are comparatively scarce, the females being self-

fertilizing in most cases. This creature is evidently in a transitory stage of evolution.

The larva is six-legged, minute and very active. About eighty are produced by one female, who thereupon dies and the young grubs live inside her dried-up outer casing. When full-fed they come out from the scale and disperse, fixing themselves by their probosces to the trunk of the tree, when the business all starts *de novo*. Males undergo a sort of pupal state, and emerge as winged creatures. (See Plate 18.)

As regards natural enemies, the Tits, the Wryneck and the Treecreeper all eat Mussel Scale and should be encouraged in every garden. Certain small Hymenoptera (*chalcididæ*) also prey on them, but without doing much good. Washing the trees with a solution of paraffin, soft soap and caustic soda is recommended.

Turning to the leaves, we have of course the Aphis again. For these, however, see Appendix.

I shall now take the Winter Moth (*Cheimatobia brumata*) in some detail, as it is very much on the black list of orchard pests, and we will try to look into some of the causes which have made it what it is.

Fruit will not ripen without leaves, which are the lungs of a tree, and the first and worst example of leaf-devourers is the Winter Moth. (See Plate 18.)

This little moth measures about an inch across the wings, which are extremely variable in their markings, no two specimens being alike. The general colour scheme is grey-brown in the case of the fore-wings with several transverse darker bands. The hind wings are much paler, with a darker border and sundry concentric wavy lines.

The female moth is almost wingless, those she possesses being mere stumps, quite useless for flight. On the other hand she is very nimble of foot and spends her time running about on fences, whither the fluttering suitors are attracted.

Why are the females of some moths wingless? Here is a little story in evolution which we may as well look at in passing.

These moths are usually in their adult stage during the cold season, when most insects are dormant and most birds have to go hungry. The obvious connexion between these two facts will at once be seen. Clearly the comparatively heavy-bodied female would want considerable wing-expanse to carry her about, and would therefore be a most conspicuous object for the famished robins, thrushes and sparrows. As a result those females who were wily enough to hide up had the privilege of continuing the race, whilst the giddier girls were picked off, and so selection has brought about in the course of ages these apterous females whose disused wing-stumps are all that remain to remind them of their former soaring capabilities.

Why have we been "blessed" with the Winter Moths in our orchards? It is not because we have robbed these creatures of their natural food, for their larvæ eat white-thorn, blackthorn, birch, hornbeam, oak, hazel and other forest trees, as well as apple, pear, plum and cherry. It is another case where we have departed from the ordered path of Nature. We have substituted a superior for the wild food, and as a consequence these little moths come gaily to the feast, exactly as the Cabbage butterflies do in the kitchen garden. There, however, the ichneumon parasite has a good deal to say in the matter that is to our advantage.

The Winter Moths, although preyed upon to some extent by muscid and ichneumon flies, and subjects for the cannibalism of such caterpillars as that of the Dunbar Moth, are not yet so well under control. Here, I fancy, we are witnessing the intermediate stage. Presently Nature will say "Stop!" to the Winter Moths and then an ichneumon or other fly will be found increasing by hundreds and thousands until the plague of green caterpillars is a thing of the past.

Meanwhile, let us not forget the birds. If only we would grasp the fact that insectivorous little birds like the Golden-crested Wren and the Tits ought not to have been driven away we should do a great deal to render our orchards immune from the attacks of these larvæ.

The female Winter Moth leaves her fence when ready to lay and crawls up the tree-trunks to place her greenish eggs in the crevices of the bark. Banding the trees with a mixture of tar and cart-grease must be done in November, and repeated to keep it fresh. Thus the moths will be prevented from getting up into the branches. Pruning must be delayed until after Christmas, as by then all eggs have been deposited and the moths are dead. The prunings should be burnt. After this nothing further can be done than to leave the titmice and bullfinches to pick out any eggs or newly hatched larvæ which will soon eat their way into the buds in spring. Later on, "beating" is useful as if the tree is struck with a cloth- or rubber-covered mallet the jarring will dislodge numbers of caterpillars, which lower themselves by their silken threads and so may be collected and destroyed.

The pupæ of this moth may be sought on the surface of the ground at the base of the trees in June until November and cleared away for the fowls.

Arsenical spraying of the trunks is useful, but it should be noted that the female moth lays her eggs all over the tree, so that the whole of it must be done. Even then the wind blows the thread-borne larvæ from place to place, and I would therefore rather emphasize constant vigilance at the various times indicated above.

There are other Winter Moths, such as the Mottled Umber (*H. defoliaria*) and the March Moth (*A. æscularia*), which attack fruit trees and are also harmful in woods. They too have wingless females, and treatment as described above also applies. (See Plate 18.)

In some parts the Vapourer Moth (*Orgyia antiqua*) has been found troublesome. This is a *summer* moth with a

wingless female and is very common in London parks, where it feeds mostly upon the leaves of the plane trees. The males measure about an inch across the wings, which are all of a rich red-brown colour, with one white spot on the hind margin of each fore-wing. This is the little moth which flies madly about in an odd, jerky fashion, during July and August, even in the heart of the City. Its mate is clad in plain grey, and never leaves the web-like cocoon in which, as a jet-black pupa, she passed the winter, and over it she lays all her eggs. These cocoons may usually be found under the copings of walls, and the baby Vapourers, when hatched, at once drop to the ground, often having to crawl an astonishing distance for their first meal, or possibly their second, for many caterpillars will eat the empty egg-shell by way of a start in life. These caterpillars, after the first change of skin, are clad in a most gorgeous and elaborate livery. All down the back they are adorned with tufts of yellow hair, looking like a row of shaving brushes stood on end. The general colour is greyish-brown with yellow "slashings" and crimson buttons at the side, the whole embellished with a scheme of hirsute appendages which an Assyrian king might well envy. And all this may hatch out into a modest little grey female without any wings!

Talking of liveries, we must not forget the Lackey Moth (*Bombyx neustria*), whose larva, one of the so-called "tent" caterpillars, among which are the Gold-tail, Brown-tail and other moths, is often injurious to apple trees; it is in fact widely distributed over the southern countries and the Midlands, but is not met with so frequently farther north.

In the orchards of our home counties this larva is addicted to apple, pear and plum trees, but principally the apple. It spins webs all over the trees, giving them a sickly unhealthy appearance.

This caterpillar is even more showy than that of the

Vapourer Moth. It is long and slender, measuring about 2 inches when full-grown. The head is blue-grey, the rest of the body being gaily striped with white, black and orange on top, the sides black with bright blue "buttons," the under portion blue-grey with black spots, the whole covered with short yellow hairs. It is a case of the glaring note in Nature's protective scheming. Most birds shrink from this highly coloured creature, which comes out of its web, boldly conspicuous, and suns itself on bright days. It has an additional protection in that, when touched, the hairs produce a painful irritation of the skin, so that it must only be handled with gloves on. The Cuckoo however, which must have a throat like a nutmeg-grater, makes little ado about Lackey Moth caterpillars, and devours them wholesale. Moral, shake hands with yourself when you hear the cuckoo call.

The Lackey Moth itself is a commonplace affair measuring about 1½ inches across the wings, which are red-brown or yellow with transverse paler lines in front and a concentric band behind. They vary considerably in different specimens from yellow to brown. The eggs are laid in the autumn in the form of a dainty little series of rings around the twigs, very much like the "snake" bangles worn by ladies. They hatch out in April, so that during the winter a careful watch should be kept for these "bracelets" in order that they may be removed. As they are laid all over the tree it will be seen that dwarf varieties of fruit lend themselves more readily to egg search.

When full-fed the caterpillar spins a neat, oval cocoon amongst fallen leaves and in the grass. This cocoon is made of material like manilla paper, rather dark, and is manufactured by the insect from silk and a sulphur-coloured powder which it secretes. These cocoons are characteristic of the Eggar family, including the Emperor, Kentish Glory and other fine day-flying moths, and of which the Lackey is the only really injurious member.

Various other large moths are recorded as feeding on the leaves of the apple, including the Dot, the Elephant, the Eyed Hawk, the Tiger, and the Lobster Moth, whose odd-looking caterpillar sets up its head and tail when startled, and possesses the peculiar filament appendages which give it a resemblance to the crustacean it is named after. These insects, however, all belong to the natural fauna of the country and really need not be considered in the light of pests.

The Cockchafer Beetle is also injurious to the leaves of apple trees, but I shall deal with that insect in the chapter on soil pests, where wire-worms and millipedes which are root-eaters will be considered in full.

Coming to the flowers and fruit, we find first of all the Apple Blossom Weevil (*Anthonomus pomorum*) which attacks the bloom in such a way as often to be mistaken for the action of frost, causing it to wither and drop off. This insect is only $\frac{1}{4}$ inch long, black with greyish down, a V-shaped mark being prominent on the wing-cases. Its larva is yellow with a brown head. The beetle itself feigns death when shaken off, and the trees should be beaten for it, a cloth being spread out underneath. The culprits must be swept up quickly, as when they think their little dodge has worked long enough they begin to scutter off.

During the winter months, the weevils hide away in chinks of bark and among mosses, turf and lichens, so that a word to the wise is sufficient in this respect. Spraying the trees with caustic alkali in February is also useful.

Incessant vigilance is necessary with weevils, and I strongly recommend the beating of the trees in the spring as the readiest way of catching them. They also have natural enemies in the Tits, Wagtails and the Tree-Pipit, which deserve notice.

The Apple Sucker (*Psylla mali*) is quite another kind of insect. It is really a poor relation of Mrs. Aphis, but

makes up for its humble walk in life by the extent of damage which it does. The creature is only ⅛ inch long. It attacks leaf-buds, foliage and flower-buds, the most serious being of course the last. Its presence is shown by the failure of the buds to open and by their being covered with a dirty, sticky stuff called "honey-dew."

During its larval state the Apple Sucker hops about like a frog fly, but when full-grown both sexes have wings. In colour they vary between yellow, green and red, and the females are brighter in tint than the males. The egg-laying begins in the autumn and continues until November, the young shoots being covered. They hatch in the spring and become full-grown by the middle of May.

Paraffin emulsion should be used directly the apples have been gathered and the operation may be repeated again in the spring.

As regards natural remedies it may be mentioned that the Golden-crested Wren is fond of Apple Sucker and is a well-behaved, harmless little bird which should be cared for. The Tits also help, but in the case of pears they are usually unable to resist the ripe fruit.

Wasps are regarded with aversion by almost every one in the country, on account of two outstanding faults, viz. the power to sting at will, and repeatedly, unlike bees, which sting once in self-defence and then are usually killed by their companions. Wasps also, of course, play havoc with the plums and other ripe fruit. Their saving graces, if they have any, lie in the fertilization of flowers and the devouring of other insects, for instance the Small White Butterfly. The Common Wasp (*V. vulgaris*) builds a wonderful nest underground out of paper-like material as a home for the queens and nurseries for the young grubs. Here they remain dormant during the winter and are sought out by country folk and destroyed with hot tar. Another species, the Tree Wasp (*V. norvegica*) builds a remarkable nest suspended from the boughs in woods. It is not so common as the preceding.

Earwigs, injurious to fruit and flowers, are best trapped with hay in inverted flower pots.

Every one has experienced the disgust with which one discovers "the goodly apple rotten at the core" and has crushed the offending maggot, if present, underfoot, as soon as it has been brought to light. This is usually the work of the Codlin Moth (*Carpocapsa pomonella*) which measures about ½ inch across the forewings, being dark grey with wavy brown lines, and the hind wings a uniform tint of grey-brown. (See Plate 19.)

The moths hatch out at the end of May and fly at dusk, when the female lays her eggs singly on the young fruit, or else on the leaves and twigs. The grubs enter the apple through the calyx or "eye" and eat away the pulp around the core. The period of growth is about four weeks, when it bores its way out again and turns into a brown chrysalis in a chink of bark or among dead leaves.

All rubbish should be cleared away and harbouring crevices opened out as much as possible. An alkaline winter-wash is useful. Arsenate of Lead in the spring is also recommended, but remember that this must not be done until after the blossom has fallen or there will be danger of poisoning the bees. In any case I think that the alkaline wash is best, added to the vigilance which spells real success against all these troubles.

Rotted cores may also be the work of the Apple Sawfly (*Tenthredo testudinea*). The maggots of this and the preceding insect are often confused, but the Codlin Moth has only eight pairs of legs, whereas the Sawfly boasts of ten. In colour the Sawfly is black above and reddish yellow underneath. It measures about ½ inch across the wings. (See Plate 19.)

The adult fly leaves the cocoon at the beginning of May when the trees are in flower and sits on the blossoms. Sticky fly-traps might be suspended in the trees in fine weather. The egg is laid on the blooms, one on each, after which the fate of that apple is sealed. The period

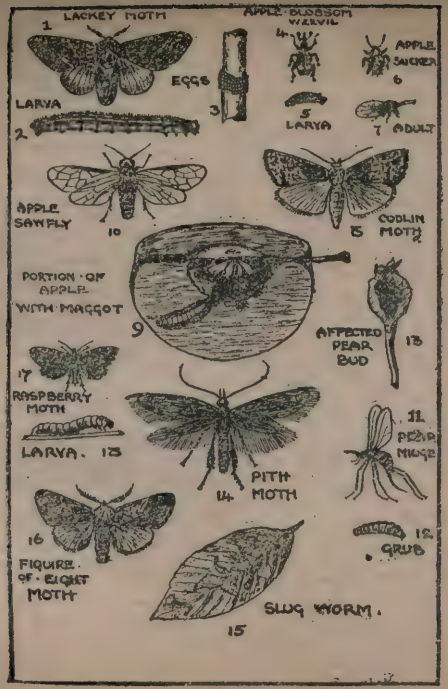

PLATE 19.
Apple, Pear and Plum Pests.

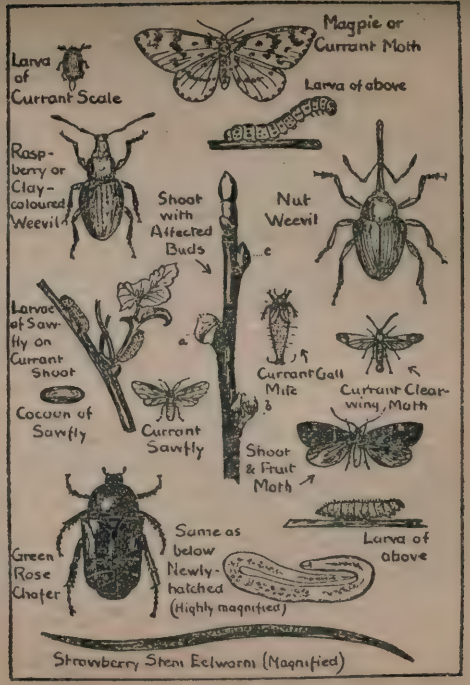

PLATE 20.
Magpie Moth, and Bush Fruit Pests.

of growth is from four to six weeks, when the grubs leave the fruit and go into the ground. Sprays have not been found very successful in this instance and therefore great diligence in soil fumigating in winter should be resorted to, to destroy the pupæ at the base of the trees.

Our study of the Apple may be concluded with a brief reference to the Pith Moth (*Laverna atra*) which burrows into the shoots of the young trees and causes much damage at times. It measures about ½ inch across, the front wings being often quite black, with a few white streaks, the hinder wings grey, with long and beautiful fringes. The caterpillar is flesh-coloured with dark-brown head, and the pupa bright brown.

The moths come out in July and lay eggs on the leaves, where the larvæ feed for a short time and then bore away into the shoots in which they pass the winter. A small blister indicates their presence.

Winter pruning and search for the said blisters constitute the best remedies. (See Plate 19.)

Many of the foregoing insects are also destructive, as has been stated, to pear, plum and cherry trees, and the same measures may be used against them. These trees have, however, other pests peculiar to themselves. An illustration is given of the Pear Midge (*Diplosis pyrivora*) a delicate grey creature barely ⅛ inch long. It is capable of much damage by attacking the young fruit, the female driving her long ovipositor straight into the calyx and there depositing anything from fifteen to twenty eggs. By the middle of June the larvæ, which are without feet, yellowish-white, and nearly ¼ inch long, leave the fruit and bury themselves in the ground, spinning silken cocoons and emerging as midges the following spring about the middle of April. A sketch is shown of a young fruit attacked by this pest. (See Plate 19.)

The best remedy in small gardens is hand picking and the destruction of the affected pears, which cuts off a generation midway in its career. Here again those with

dwarf trees score a point. On a larger scale, soil dressing with kainite will kill the larvæ in the autumn. Gas lime is no good unless it can be very finely pulverized, nor is there much to be said for spraying. In bad cases, where very few pears are likely to reach maturity, the drastic course of sacrificing the whole crop and burning it would deprive the Midges of their means of continuance into the next season.

Another trouble in pear and cherry orchards is the Slugworm, which is the larva of the Pear and Cherry Sawfly (*Eriocampa limacina*), a disgusting-looking maggot which gnaws away the leaves of pear, damson, cherry, peach, plum and apple trees. They are also known as "snegs."

The adult fly measures ½ inch across the wings, which are dusky grey with a transparent border, the body being black. The larva, which is white at first, soon becomes covered with a protective ugly green slime, and indeed looks very much like a slug gone wrong or a tadpole with the influenza. It is about ½ inch long when full size, and although it has ten pairs of feet, it cannot get along very quickly, distinctly sluggish in fact. In later life its appearance is somewhat improved, as the slime is discarded, and its colour changes to yellow or buff. (See Plate 19.)

The adult flies come out in early June, and proceed to saw up the leaves, slitting through the tissues and depositing eggs therein. The larvæ hatch in about a week, and there are several broods in a season.

As the pupæ are in the soil at the base of the trees, this should be got up in the autumn with a Canterbury hoe and broken finely, quicklime being worked in thoroughly. In bad cases this soil should be removed and burnt.

Poultry, if penned beneath the trees, would pick up the larvæ in the autumn as they fall.

Pear and Plum Trees sometimes afford a home for the Figure of Eight Moth (*Diloba cæruleocephala*). It is not

as serious as the midges and sawflies, and I am almost loth to include it as a pest. At the same time it is common throughout England, and leaf-eaters can do a lot of harm if left unchecked. (See Plates 19 and 26.)

The moth, which appears in September, measures about $1\frac{1}{4}$ inches across the forewings, which are leaden brown in colour, with a mother-of-pearl gloss, and contain the curious white marks like figures of eight. The hind wings are dingy brown with a black blotch on the lower angle.

The caterpillar, which is full-fed in June, feeds naturally on the whitethorn, and also on blackthorn, allied to the plum botanically, and is grey-green with yellow stripes at the side.

The eggs are laid on the shoots in September, whence they may be removed if observed, and hand picking in the case of dwarf trees would come in. The measures adopted with the soil at the base for other pests would serve to deal with the pupæ which would be found there during the summer months.

We must now turn our attention to bush fruit. Here there is a very wide field and pests seem to be even more troublesome than in the case of large trees. The cause for this is, I believe, the reduction of the natural flora by the increase of cultivated areas. In most cases our only method of meeting the situation, at present, is to carry the war straight into the enemy's camp, so here goes.

Let us take the raspberry first of all. This plant is allied to the bramble and the dewberry among our wild fruits of the Rubus family, with which indeed crosses have been made. It may be taken as a fairly certain rule that where an insect feeds upon the wild relative it may also be found upon the cultivated fruit, and half the battle is to look for these things in advance.

The Raspberry Moth (*Lampronia rubiella*), whose larva is known as the Stem-bud Caterpillar, is most destructive

at times to the canes. It is a pretty little moth, belonging to the vast group of the Tineina, still insufficiently known, and measures nearly ½ inch across the wings, which are light brown with yellow spots in the case of the forewings, the hinder ones having a pale fringe. The caterpillar is red with a black head and a black spot on the first segment. The pupa is reddish-yellow.

Eggs are laid on the flowers in the spring. The caterpillars, which are slow of growth, hibernate during the winter. They then make up for their long fast, commencing in real earnest the ensuing season, eating into the buds at the base and so preventing the flowers from opening. The larvæ then scoop out a hole in the pith of the cane and there pupate.

As the caterpillars hibernate just below the surface of the ground, poultry would be useful for a certain time, but deep forking or even the use of the Canterbury hoe will bury them too deep to get out again. In bad cases the canes can be cut off and burnt, after which soot and lime should be worked into the soil. (See Plate 19.)

An insect closely connected with the foregoing is the Shoot and Fruit Moth (*Incurvaria capitella*) which is inimical to red and black currants. In this case the plants are attacked by the larvæ in their youth on the fruits, and when older they make their way into the shoots. The moth measures about ½ inch across, the fore-wings being dark purplish brown with pale yellow spots, and the hind wings are purple grey. The caterpillar is light red or greenish-yellow, and hibernates like the last example. The eggs are laid in the fruit during May and June, and the larvæ as stated do not complete their development until the following spring.

A wash of caustic soda in winter is recommended, but hand-picking and burning of infested drooping shoots should be constantly done. The Blue Tit is one of our allies in dealing with this pest, as it accounts for numbers of the hibernating larvæ. (See Plate 20.)

The Raspberry or Clay-coloured Weevil (*Otiorhynchus picipes*) is the best known of the weevils and beetles which attack raspberries, and a description of it may be given here, as the method of checking will serve for the others. It is about ¼ inch long, and brown or clay-coloured, so that it is difficult to see it on the ground. Nature is of course the only adept at camouflage, and striking evidences of the fact meet us at every turn. This little weevil has no wings and is in the habit of feeding at night. The larva is whitey-brown in colour with a brown head. The eggs are laid in the ground, and the grubs feed on the roots from midsummer to spring, when they change into a white pupa with black spots over the eyes. They attack many other plants, such as vines, strawberry, mangold, peas, beans and turnips, to which may be added various flowers both in greenhouses and in the open air.

Drastic soil dressings are necessary where the pest has got a firm hold, using gas-lime, and where the crop can be moved to another situation the following season this should be done. The tits, blackbirds and thrushes should be borne in mind, as they are very fond of these weevils, and certain sand-wasps (*Odyneri*) kill or paralyse them and carry them off to their nests with which to feed their young. (See Plates 20 and 24.)

We now come to currants, where a number of creatures await our attention. There is first of all the Currant Scale (*Lecanium persicæ*), an insect found commonly on currant, gooseberry, rose, plum and other trees, both wild and cultivated. As in the case of the mussel scale, to which this is allied, the females of this strange group of the Hemiptera have the unusual quality of being sexually complete and therefore self-productive. The male Current Scale, if it exists, is evidently a very insignificant factor in their economy. The Scale is about $\frac{1}{50}$ inch long, and has legs in the larval state but becomes stationary in maturity. They fix themselves under partly detached portions of bark in order to pass the

winter, when the bushes should be sprayed with caustic soda wash. (See Plate 20.)

Next is the Currant Sawfly (*Nematus ribesii*) which perhaps is just as well named the Gooseberry Sawfly, as it leaves its mark on the one bush as much as the other. They clear the leaves off altogether in some seasons. The larvæ, which are green with black spots, have the twenty legs which distinguish all sawfly larvæ from moth caterpillars, who only have sixteen, and are nearly an inch long when full grown. It changes into a green chrysalis within an oval brown cocoon, and the adults, which measure nearly ½ inch across the wings, first come out in May. There are several broods in the season. The eggs are conspicuously laid along the veins of the leaves, and so little need be said as to how to deal with them. Various sprays are used against the caterpillars, but I recommend strong lime water only, sprayed all over the bush. In the winter also a good plan is to remove all the surface soil for some inches beneath the bushes and replace same with fresh. (See Plate 20.)

The Currant Gall Mite is not an insect, but an Acarus, minute creatures produced from eggs, but undergoing no preliminary stages of development. The present species (*Eriophyes ribis*) which affects currants and gooseberries is only $\frac{1}{100}$ inch in length, and so can scarcely be seen without a pocket lens, but its effects are apparent enough in the shape of the "Big Buds" from which the plants suffer in the spring and which afterwards dry up and die. Incredible as it may seem, these tiny creatures have a still tinier parasite, an insect which calls itself *Tetrastichus eriophyes*, but I am afraid I cannot convey any notion as to the size, or rather the smallness of this little helper whose larvæ eat Currant Mites, or how you box it when its presence is rumoured. Our methods of control are chiefly change of site for the new bushes when the old ones are burned, although spraying with soft soap and sulphur in the springtime may be tried. These, added

to the hand picking of swollen buds, are all we can do at present, and again, success is more likely to come to him who is early on the job. (See Plate 20.)

The Magpie or Gooseberry or Currant Moth (*Abraxus grossulariata*) is well known to everybody. This is the dainty creature which flits about all over the garden and lays its eggs on practically every shrub without any regard to flavour, shape or size. The larvæ must be able to eat anything, but the fruit-grower is only too well aware of the way in which it defoliates his best currants and gooseberries. Black and yellow are the colours which characterize this insect through all its stages, another exception to the general rule. I would recommend egg search here again, as they are laid, two or three here and there, in prominent positions on the top of a leaf, and the Magpie females will do it under your very eyes if you watch them in the garden on a fine sunny morning in July or August. The grubs hibernate during the winter and come out of their hiding-places among the dead leaves in spring to spin a silken cocoon in which they change to a glossy black and yellow pupa. Hand picking is also of course of great value. (See Plate 20.)

There is a wood-borer in the shape of the Currant Clearwing Moth (*Sesia tipuliformis*) a gnat-like creature which eats away the wood in the shoots of red and black currants. It is not half as serious as the Bud Mite, nor so prevalent but its presence may be detected by the brittleness of the shoots, which if broken off will disclose the maggot within.

The Nut Weevil (*B. nucum*) is a curious insect, as will be seen from the picture. It is provided with a mighty weapon in the shape of a bodkin-like growth in front of the head with which it pierces the young hazel nut on which it subsists. As has been stated before, weevils are the most difficult of insects to grapple with, and their numbers are legion. There has not been enough "beating" for them in the past, and a systematic shaking out of the bushes should be taken in hand as a check to

the Nut Weevil. The insect measures about $\frac{3}{8}$ inch in length and is nut-brown in colour. (See Plate 20.)

Our last case will be that of the Strawberry, where we find the green Rose Chafer (*Cetonia aurata*), a most beautiful golden-green insect which reaches the adult stage in the month of June. It is however destructive to the leaves and flowers of strawberry plants as well as to roses and turnips, evidently liking a varied diet. Like the Cockchafer, the larva of this insect lives in the soil, as long as two or three years, where it eats at the roots of the plants. The best method of dealing with them is to knock out the beetles from trees and shrubs and destroy them, the gas-liming of the soil being also taken in hand during winter to dispose of the grubs. Rooks, starlings, plovers and gulls devour large numbers. (See Plate 20.)

Strawberry plants are also subject to the Stem Eelworm (*Telenchus devastatrix*), a tiny creature only $\frac{1}{2}$ inch long, which bores into the tissues of the plant. The adult worms lay eggs which may remain in the dead tissues or in the soil for some time before hatching, and as they are very prolific it becomes very difficult to cope with this pest. Clover, grasses, plantain and other weeds are affected by eelworm. The best method of dealing with it is the artful one of putting down a catch crop which eelworm readily goes to and then uprooting it with the eelworms therein. (See Plate 20.)

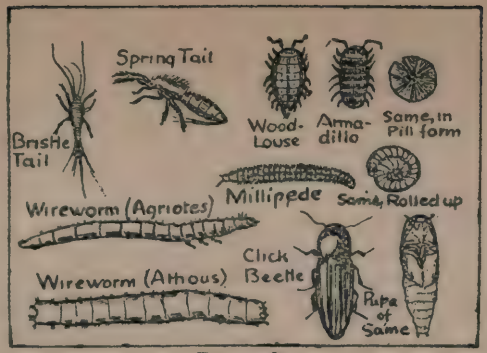

PLATE 21.

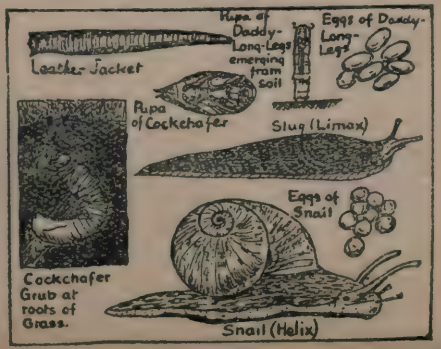

PLATE 22.
Injurious Soil Dwellers.

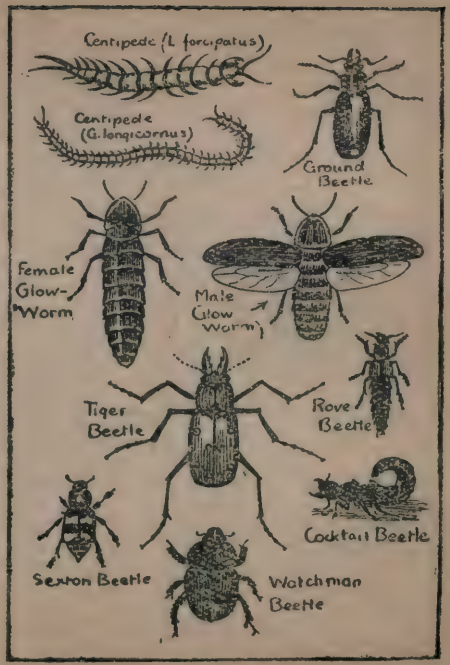

PLATE 23.
Beneficial Soil Insects.

CHAPTER V

SOIL PESTS

Thysanoura or Bristle Tails—Collembola or Spring Tails—Myriapoda—Millipedes—Wireworms and Click Beetles—Leather-jacket or Crane Fly—Snails and Slugs—Cockchafers—Insects useful to Soil—Bacteria and Earthworms—Beetles—Centipedes.

THIS chapter need not be an over long one, as we shall find that many of the insect pests which are met with in the soil have been grouped under the particular plants they infest and already treated of elsewhere.

Certain insects, however, are manifestly referable to the soil in general, and of these we must now speak.

Soil insects, to whatever class they belong, may conveniently be considered under two distinct heads, viz. those which are carnivorous, and those which devour herbage.

We will take plant-eaters first. Of these it is well again to distinguish between those which merely devour *decayed* vegetable matter, and those which deliberately attack the living tissues. There are many classes of insects and other creatures which find sustenance on decayed vegetation; and this function is certainly a useful one, although speaking generally the creatures themselves are of an unpleasant appearance. This last fact has caused the popular prejudice against Spring-

tails, Woodlice, Pill Insects, and Centipedes. Still, the way to prevent their appearance is perfectly simple. Keep your garden, your holding, and your poultry-run absolutely clean and tidy. To allow rubbish to lie about is to ask for Woodlice: to allow old tools, planks of wood, etc., to lie on the ground and become damp, is to ask for Spring-tails, Beetle larvæ, Slugs, Snails, and such creatures, to come in and make themselves at home.

Everything in and about the gardener's and small-holder's establishment must be "weathered" when kept out of doors to allow unobstructed passage of rain, and prevent accumulation of mud and mould. Indoors, everything should be kept free from dust and damp. Remember that the elements are always trying to wear down the works of man, as well as the face of Nature.

Some people seem to think that a good coat of paint ought to last for ever. At any rate they never give it a second thought, and then wonder why decay sets in, bringing along the creeping things whose status on Nature's Board of Works is simply that of scavenging. A moment's reflection upon, say, the geological fact that the granite cliffs which hold up Niagara are worn away six inches every year (and this has been going on for countless ages) will show how little permanence there is in anything that we do, even for our own lifetimes, unless we are constantly tidying up, and "making good." If this is done, however, scavenger insects will be kept in their true place, in the woods and forests, where Nature's life can go on undisturbed.

The Thysanoura, or Bristle Tails, are a lowly branch of the Neuroptera, and are apterous or wingless insects, having six legs, as well as the bristle-like appendages, at both ends of the body, which enable them to leap very well. They undergo no metamorphoses in their development. The common Bristle-tail, which is found in outhouses, in the chinks of sashes which are never opened, under damp boards, or at the backs of ward-

robes, is greyish white in colour, and scarcely ¼ inch over all. (See Plate 21.)

The Collembola, or Spring-tails, closely resemble the foregoing. They are much the same size, and are most commonly found under decaying leaves, and in loose earth, always where there is dampness. Cold weather has no effect on them, in fact their breeding time is said to be during the winter months. In this respect it may be mentioned that these insects exhibit a certain affinity to fish, from which in the long course of ages the reptiles, and from them the insects, have been developed. It was suggested by Lord Avebury that the Thysanoura could be looked upon not as insects proper, but as the sole survivors of the original type of creatures from which all insects have come. A specimen is shewn with its tail bent under and about to leap into the air. This kind is found under stones and other damp places. (See Plate 21.)

Of course one need not wallow in neglect for fear of disturbing the dear little Bristle-tails. Their detailed history is perhaps more interesting to the student than the gardener, and I think it is quite obvious how they may be induced to "hop it."

We now come to Woodlice, about which little need be said, as the situation and conditions under which they accumulate are much the same as in the case of the Spring-tails. The three common forms of Myriapods are shown, and none of them, contrary to the common notion, are what I would call really harmful. Call them rather disagreeable insects, and bustle around with broom and scraper, paint-brush and creosote. Little will then be seen of woodlice. (See Plate 21.)

With the Millipede we get a really harmful creature. The species shown (*Julus pulchellus*), usually grows to about ¾ inch in length. This is the insect which eats into the crowns of our carrot and parsnip crops, and does a lot of damage often attributed to Wireworms. There

are thirty or more segments to the body, each bearing *two* pairs of legs, an important distinction between this pest and the centipedes, which are in many ways beneficial. It is pale yellow in colour, and curls up like a watch-spring when disturbed, being slow moving and sluggish in habit. Millipedes are encouraged where ground is neglected, and bad cultivation has been allowed. The allotment holder must therefore act the policeman so far as Millipedes are concerned, and by the aid of a hoe, persist in his "pass along please" until, like Weary Willie and Tired Tim, they move off muttering somewhere else. If this is not enough, powdered naphthalene should be tried, or potato traps, afterwards boiled and given to the fowls. Poisoned potato traps should never be employed, in my opinion, as it is quite unnecessary and they cannot then be used for the poultry.

We now pass to Beetles. As was stated at the commencement, beetles and their larvæ are found everywhere and in all circumstances, so we need not be surprised to find that the soil has its Coleopterous denizens, both beneficial and otherwise. The outstanding example of the "otherwise" is of course the Wireworm, which is so notorious that plenty of damage of which he is innocent has been attributed to him. "Give a dog a bad name and you may as well hang him." In this case, however, a great deal of the opprobrium is well deserved.

The Click or Skipjack Beetle, as this insect is called when full grown, from its habit of clicking its abdomen against the top of the thorax, and so turning a somersault, belongs to the genus Elateridæ, which include the fireflies of tropical countries. There are several English species, all very similar and all known in their larval state as wireworms. Two only need be mentioned—*Agriotes lineatus* and *Athous hæmorrhoidalis*. Their history is as follows. Eggs are laid during the summer months on pasture land, beneath the roots of which the resultant wireworms feed and travel about in the soil for as long

as three to five years, encroaching on field and garden crops, attacking potato, carrot, beet, parsnip, etc. They also tunnel up into the stalks of the tomato, a plant which is tolerably immune from the depredations of insects. For natural remedies we must mainly depend on moles, which eat the wireworm summer and winter; and insectivorous birds, notably the meadow pipit and the starling, whose beaks are specially suited for getting out soil insects. Where a field has been under grass for a length of time, and is being broken up for cultivation a strong dressing of gas lime should be given in the winter, followed in the spring by 3 ozs. of naphthalene to the square yard, previous to sowing or planting. This should be effective against wireworms. The pupa of this pest is white and easily injured by the laying open of the soil, so that turning poultry on to the ground where newly dug is useful. The beetles usually hatch in June and July. (See Plate 21.)

The Cockchafer or May bug (*Melolontha vulgaris*) is quite as bad as the foregoing, and its "white grub" is looked upon with disgust whenever it is turned up from beneath the roots of meadow grass, where it does its fell work for a space of three years. It also attacks fruit trees, as well as hops, flowers, corn, and vegetables.

There are several kinds of Chafer beetles, including the Garden, Rose, and Summer Chafers, all of which are inimical to the roots of crops. The sketch of Melolontha vulgaris and its larva and pupa will given an idea of the form of them all. It is the largest of this family and measures $1\frac{1}{2}$ inches from the tip of the snout to the end of the abdomen, and although the body is black, it is so covered with a yellow down that when newly out it has a light appearance. The female burrows into the earth, and lays her eggs in batches of ten to twenty-five, there being perhaps seventy in all. The larva and pupa are quite white. During their long lifetime these grubs do an incalculable amount of damage to vegetation, and

when they emerge as beetles after the third year they are just as destructive in defoliating plants, fruit and forest trees. Systematic beating of the trees for the destruction of the beetles themselves is one of the methods that must be followed in a bad year, and the ground must be opened out in autumn for rooks, starlings, plovers, and gulls, who will pick out the larvæ in large numbers. In addition, heaps of turf, litter, etc., may be used as traps, and should be frequently turned over for the white grubs which collect therein. Gas lime and kainit as dressings may be used, the former in the winter. Also, when hoeing, a watch should be kept with a view to hand-picking. (See Plate 3, Fig. 12, and Plate 22.)

Another soil nuisance is the Leather Jacket, which is the larva of the Daddy-long-legs or Crane fly (*Tipula oleracea*). There are several kinds of Crane fly, more brightly coloured than the greyish brown insect familiar to everybody, but they are not so common as *Tipula oleracea*. (See Plate 2, Fig. A, and Plate 22.)

The larva is about an inch long, brown, with a small head which can be drawn back into the body, and possessing the strong jaws which are responsible for the root injuries so often complained of. The female crane-fly lays her eggs, 200 to 300, on meadow land in August, and the grubs feed all through the winter, often coming out on mild days in January, when they are soon taken by some hungry bird. The pupa is as long as the larva, and, as with all pupæ, has traced on its outer surface the outline of the future insect. Gas lime in winter is the best treatment, preceded by as much opening of the soil as possible, to give the starlings and rooks a chance, who are very fond of Leather Jacket. Later on, for the farmer, harrowing and rolling has the effect of bringing the grubs out, again to be taken into the birds' larder.

Snails and slugs are not insects but molluscs. They are often a great nuisance to the gardener, however, and so a word or two here about them may be acceptable.

The two families, Slugs (*Limacidæ*) and Snails (*Helicidæ*) are closely allied, and belong to the class Invertebrates, or animals with no backbone.

The commonest species is the Grey Field Slug (*Limax agrestia*), which devastates all kinds of crops from grass to corn, and also destroys flowering plants, and the young shoots of bush fruit. The general form of the mollusc is seen in the sketch. There is also the Black Slug, the Yellow or House Slug, and a small kind known as the Bulb or Root-eating Slug. They are all of much the same form and the same remedies apply. The method of propagation is by means of eggs, which are laid during the summer months in the soil or under rubbish. The eggs are circular, milky in colour, and occur in batches of ten to fifteen. Needless to say, moisture is indispensable to slugs and snails, which are alike also in that they do their mischief by night, the former hiding in crevices and under stones during the daytime. This habit may be taken advantage of by placing cabbage and lettuce leaves on the ground in the evening, and taking them up early the next morning, when the slugs which have crept in underneath may be captured and given to the fowls. (See Plate 22.)

Snails are quite an interesting family in their way. Some of their shells have very beautiful markings, and structure, and are collected for that reason. Also, particularly in France, snails reared on a milk diet are esteemed a delicacy for the epicure. English people do not fancy them as a rule. The Common Garden Snail (*Helix aspersa*) is a destructive creature, feeding greedily on the tender green shoots of vegetables and flowers, almost indiscriminately ; the dahlia for instance, with its acrid flavour, will often have its first shoots gnawed off by these creatures so as to spoil the plant entirely. The eggs of the Snail, laid in batches in the earth, are white and similar to those of the Slug. There is little to distinguish between the young of these molluscs in the early stages of their development.

In addition to the Garden Snail, there is the Wood Snail, which appears early in the spring, and is harmful to clover and pasture; the Strawberry Snail, scarcely ½ inch long, and troublesome to strawberry beds and in the flower garden, and the Banded Snail, with a conical shell, white with purple-brown stripe, a nuisance on hillsides and near the sea.

Snails are more honest in their depredations than Slugs, as they feed above ground and are nearly always visible. As a consequence their control is a much easier matter than that of Slugs. (See Plate 22.)

Where crops are suffering from either snails or slugs a dressing of lime and soot should be given. Powdered alum will kill them, but it is rather too expensive to use except for choice plants. In greenhouses, cotton-wool tied round the stems of pot plants will prevent snails and slugs ascending to gnaw the young shoots.

Thoroughly foul land may be gaslimed in winter to clear it of Slugs.

The thrush is the principal natural enemy of Slugs and Snails, being an extremely useful bird in this respect, as also are blackbirds and starlings. Poultry, ducks, water-rats, moles, hedgehogs, frogs and toads, are fond of them, as also is the tortoise, kept as a pet by some gardeners on account of its insect-eating habits. The glow-worm, described later, attacks and devours snails.

We have now dealt with most of the injurious creatures found in the soil, which as stated are vegetarian in diet, whether it be the decayed or growing tissues that they feed on.

Coming to the useful class, these are mainly beetles, who perform all sorts of handy service in connection with the soil and its inhabitants, though we have in addition the Centipedes among the Myriapoda, which may be taken first. Centipedes are at once distinguished from Millipedes, even to the casual observer, by their extreme activity, as with a hundred and one wriggles

and twists they vanish from sight whenever one turns them up in the soil. The two commonest forms, Lithobius forcipatus and Geophilus longicornis are shown in the sketch. They are carnivorous in diet, feeding both on decayed animal matter as well as upon worms, slugs, beetle-larvæ and other small creatures. They do not undergo any definite metamorphoses; the young centipedes however usually have fewer legs than the adults, the obtaining of additional pairs of legs as they grow older appears to be their idea of distinction in the world. As previously stated centipedes have only *one* pair of feet to each segment, against two in the case of millipedes, and this constitutes the chief structural difference between them. Some Centipedes are phosphorescent at night, a rare quality among British insects, of which the Glow-worm, or larva of a beetle called Lampyris noctilus, is the best known example. The word Lampyris means " shiny tail " a very apt description. Glow-worms are useful to the gardener, as they feed on Snails, attacking them boldly and devouring them alive. The female glow-worm beetle is wingless. (See Plate 23.)

There are as many useful as injurious tribes among the Coleoptera and here are a few selected at random of those whose larvæ live in the soil and prey upon earthworms as well as harmful creatures among their own and other orders. (See Plate 23.)

First there is the Telephoridæ family, which include many bright-coloured beetles, some red, some blue, which country boys used to call soldiers and sailors. Others are brown and these we may suppose to have gone into khaki, not merely " for the duration " but possibly for all time. They are the most pugnacious of all insects, fighting everything and everybody, including one another. Their diet is chiefly earthworms and soil larvæ.

Then there is the Tiger Beetle or Sparkler (*Cicindela campestris*), beautiful gold green above, and coppery below, with yellow spots on the tops of the wing cases.

Its larva is a curious object, whitish in colour with a large head and humped back. It makes little traps in the ground where it lies in wait and suddenly pounces on any hapless wireworm or daddy-long-legs passing by. The odour of some beetles is the reverse of pleasant, but in the case of the Tiger Beetle, a lovely scent of sweet-briar denotes its presence. This beetle frequents sandy soil. (See Plate 23.)

The Ground Beetles, the Carabus family, are all useful. A common species (*Carabus catenulatus*) is shown. They spend all their time hunting and devouring small insects and never touch vegetables. This remark also applies to the Rove Beetles, several of which feed on the pupæ of the Cabbage Root Fly. (See Plate 23.)

Sexton beetles (*Necrophaga*) perform the useful function of dismembering and burying putrid animal matter, such as dead moles, weasels, birds, etc., which are taken down piecemeal into the soil as food for their young.

Then there are Dung Beetles, the commonest of which is the Clock or Flying Watchman (*Geotrupes Stercorarius*) which utilizes cowdung and such material for a similar purpose. (See Plate 23.)

All the insects and creatures aforementioned are what everybody may readily see in the soil. Apart from these, however, soil is full of life which cannot be seen by the human eye, in some cases not even by the aid of the highest powers of the microscope. These beings include the bacteria, which have many useful functions and play a very important part in the process of plant growth. Armies of bacteria, much more numerous than the fighting forces on the recent battle fronts of Europe, are constantly engaged in creative and destructive operations, and on the results from time to time depends success or failure to the grower. The soil is, in a word, a little universe. It is the living soil in a very real sense, and I hope to say something more about it in another chapter. Certain "go ahead" people at one time made a great fuss about

"sterilized" soil, and one would have thought they had achieved the millennium as far as gardening was concerned. The results, however, did not pan out according to book, as these good people forgot those three words, "the living soil."

Earthworms have been the means whereby we have obtained the soil itself. Their constant activities, which Darwin spent a large part of his life in studying, have gone on through the countless centuries of geological time, and we owe even the present face of nature, the drainage, aeration, manuring, and alteration of hill and dale to the never ceasing and apparently insignificant action of the earthworm, to which I shall recur in the chapter on the nature of soils.

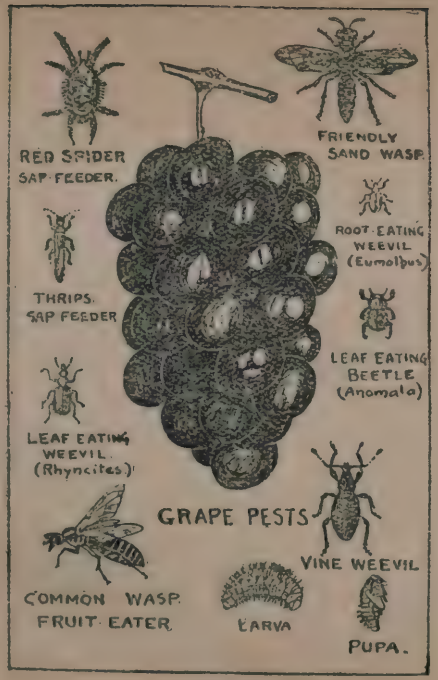

PLATE 24.
Indoor Grape Pests.

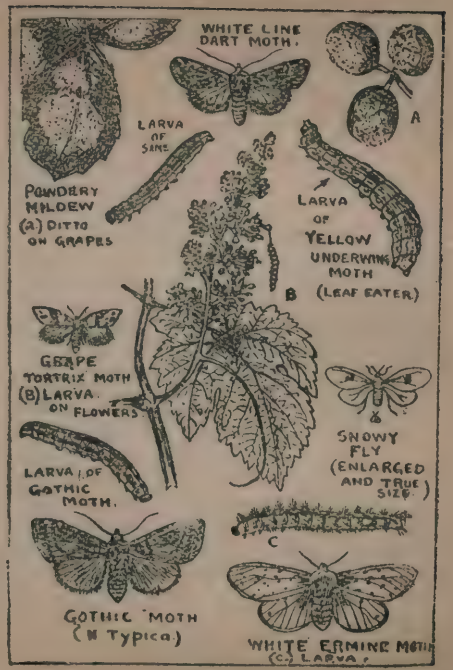

PLATE 25.
Vine Pests and Diseases.

CHAPTER VI

GREENHOUSE PESTS

Causes of Greenhouse failures—Pests of the Vine—Vine Weevils and other Beetles—Gothic Moth—White Line Dart Moth—Yellow Underwing Moth—Ermine Moths—Tortrix Moths and Microlepidoptera—Vine Tortrix—Grape Scab—Mealy Bug—The terrible Grape Louse—Wasps and Hornets—Friendly Sand-wasps—Red Spider or Spinning Mite—Fungoid Diseases—Powdery Mildew—White Rot—Figs and Pine-apples—Other Fruits—Figure of Eight Moth—Cucumber Pests—Aphides, Thrips and Woodlice—Canker on Cucumbers, Melons and Tomatoes—Cucumber Leaf Blotch—Root Knob Eelworm—White or Snowy Fly—Ants in the Greenhouse.

ONE of the first things that the novice at gardening looks forward to is the possession of a greenhouse. At the commencement of his career the terrible vagaries of the English climate are brought home to him in a very real and often very exasperating fashion. He had cursed the weather before. He now does it some more and a little bit over. At the same time, if haply the budding gardener should pass by some one's conservatory and notice how the cinerarias bloom when snow is on the ground, or he has a neighbour who points with joy to some tomato plants actually in fruit when *his* have not even germinated, he draws in his breath quickly, drops

whatever is in his hand, and says tensely, "It is enough, *I* must have glass."

A start of some sort must be made somehow. Even if it only be a couple of old window-sashes over a hole in the ground, still the magic word "glass" conjures up visions of beautiful things to come, a smiling wife beaming over baskets of early radishes and lettuce, the children browsing from punnets of mustard and cress free, gratis and for nothing off father. The newly-dug plot is all trimmed up ready to receive battalions of seedling onions, cabbage and sprouts. The young tomatoes are to come wheeling out like a squadron of cavalry whole weeks before the man who has no glass has had his sleepless nights rewarded by the first pale sign of a seed-leaf in his frost-bound boxes. Indeed the man with the window-sashes is seen to walk to his business with a firmer tread in the morning, and look the world in the eye with the bold gaze of one who *does* things.

And yet, somehow or other, for one greenhouse or conservatory that is a success there are usually about six others that are either not used, or become glorified bicycle sheds and workshops, occasionally a lumber room. Before proceeding however to define the causes of this I may as well dispose of the distinction between a greenhouse and a conservatory; so if we want to be nasty nice let us say that a greenhouse is a glass structure where the actual growing is done, a conservatory being a more ornamental but similar kind of erection where we permit ourselves with all due modesty to do the "showing off." Let us, however, content ourselves with the greenhouse, and the conservatory will look after itself.

Of course the reason why a greenhouse becomes derelict is because it proved a failure in the first season. Why was it a failure? I believe the main fault in dozens of cases is that the wrong aspect was chosen, or perhaps there was not enough attention paid to the vital question

of temperature, which *must* be kept absolutely constant if any measure of success is to be obtained. These structures are sometimes allowed to become very hot at midday and to suffer a corresponding big drop at midnight, in which case it is no wonder if plants sicken or die. A thermometer should be placed at each end, the place well ventilated when the sun is up and the fire seen to before retiring for the night. Class your plants according to the temperature they require and grow them as near to the light as possible.

But supposing all this has been carefully attended to, there is still another cause of failure, viz. the ravages of insects, whose ingenuity in getting into a greenhouse or ground frame is sometimes extraordinary. You may think there is no nook or cranny through which the tiniest parasite can possibly creep. He will be there all the same. One very patent thing about insects is their ability to enter or escape through incredibly small holes in comparison to their size. In my early days, like many boys, I used to go butterfly hunting, and frequently got the net torn in the brambles, so that after a few accidents of this sort a needle and thread was always part of my equipment on these expeditions. It had been most exasperating when, having captured a fine Painted Lady, I found her whistling away through the net and across the clover with a merry laugh, as much as to say, "Thought you'd got me, I suppose?" Yet the hole through which her ladyship managed to squeeze would scarcely have allowed a halfpenny to pass.

That is how they get out. With a greenhouse it is a case of getting in. It is surprising how the news spreads through the insect world as soon as your latest model of the Crystal Palace is erected and the workmen have left. One would think there were flying journalists and editors with bristling antennæ to wireless full particulars a fortnight in advance. And of course if you go and provide a tropical temperature in an arctic climate you must

expect things to happen and stiffen your sinews accordingly. You must justify your desire for a greenhouse by defending it against all comers.

Cockchafers will blunderingly collide with the glass in compliment to its liquid clearness and retire with certain language and a broken nose. Waterbeetles will alight with grace and spend lots of time endeavouring to take headers into the limpid depths which strangely resist all their efforts, and are only induced (upon reflection) to seek some sensible pond wherein they may rest their aching joints and tell a few friends their opinion of mankind as fraudulent copyists of Nature. If we have been so misguided as to put up our structure on the ground itself, without building dwarf walls of concrete or brick, with cement floors and plant beds of thoroughly cleansed soil, we shall have the worshipful company of wireworms assisted by youthful may-bugs fully alive to the possibilities of root-eating and stem-boring just as much in advance of the season as are the plants themselves.

If our house is built with heavy rafters that exclude the light and need a great deal of putty, these will also afford many a handy retreat for the eggs of the red spider during its quiescent period. Mealy-bug, thrips, white scale, woodlice, the winged females of green and white fly, the spores of mildew, canker and fungi will all find snug homes in such tiny cubby holes as the lappings of the glass, sash openings, door frames, struts and skirting boards, if any of these are ever allowed to harbour the merest suspicion of dirt. Moral :—Have your panes of glass as large as possible, a minimum of putty or else patent glazing, framework as light as is consistent with strength ; then swill out frequently all such harbours of trouble above referred to : give a coat of paint or creosote at favourable opportunities when the house is at rest. The milk-white cleanliness of the successful nurseryman is more than a foible of professional pride. He has

had to learn in the hard school of experience that it is absolutely a *sine qua non*.

In this chapter I propose to take the principal greenhouse subjects (except flowers) and describe the pests they are liable to suffer from. Needless to say our first example is the Vine.

From the days of remotest antiquity the Vine has been inseparably associated with man, and it has been celebrated in song and story, simile, metaphor and allegory among all nations in all ages. As a source of inspiration to poetry and religion the Vine has exercised the highest attributes of our kind, whilst in the discovery of the fermentation of its juices and the abuse of such has lain the cause of much human vice and misery.

With such a wide range and long history it was inevitable that the Vine should become the home of innumerable insect and other parasites, more particularly in countries like England where we have tried to obtain by artificial means a permanent supply, home-grown, of the finer varieties of the grape that are indigenous to southern climates.

If it can be said that heavy wines such as port are an unnatural drink for an Englishman, and when partaken of, as they were formerly, in large quantities, produce gout and other diseases, it is equally true that the black grape and all exotic kinds need the greatest care in order to ward off the enemies and ailments that will undoubtedly assail them. At the same time no man of ambition is likely to go short of a good vine because of the trouble required in looking after it, for at least the claims of the sick-room should be borne in mind, even if the dinner table goes short.

The pests of the Vine may be enumerated as follows :—

1. Beetles. A Scarabid (*Anomala vitis*) devours the soft tissue of the leaves. Another tiny species (*Emolpus vitis*) will destroy the roots. Some half-dozen kinds of weevils, of which the Black or

Vine Weevil (*Otiorrhynchus sulcatus*) is the worst offender, feed during the larval stages on the roots and regale themselves as adults upon the young leaves. We must also add the Cockchafer and the Click Beetles (Wireworms).

2. Moths. The larvæ of several of the larger moths eat vine leaves, e.g. the Gothic (*N. typica*), the White Line Dart (*A. tritici*), the Yellow Underwing (*T. pronuba*), the White and the Buff Ermines (*S. menthastri* and *S. lubricipeda*). Then there is a tiny moth called the Grape Tortrix (*Conchylis ambiguella*) which spins up in and feeds on the flowers in springtime, a second brood of the same moth boring into the fruit later on.
3. Hemiptera. Among these we have the Grape Scale (*Coccus vitis*), which infests the bark, as well as the Mealy Bug (*C. adonidum*), an insect which has been introduced from abroad, while the most deadly of all grape pests is seen in the Vine Louse (*Phylloxera vastatrix*) which attacks both roots and leaves alike.
4. Hymenoptera. Here of course the Common Wasp (*Vespis vulgaris*) and the Hornet (*V. crabro*) are the chief offenders at the time of ripe fruit. Certain Sand Wasps (*Odyneri*) are predacious upon the Vine Weevils above referred to.
5. Leaving insects, we come to Red Spider or Spinning Mite, which breed so profusely on the underside of the leaves and deprive them of their vital juices.
6. Mildew and fungi.

I might perhaps have included Aphids, Thrips, Earwigs and Flies, but these have been dealt with already under other heads, and the same remedies will apply.

As will be seen, this is a pretty comprehensive list that we have to tackle in the case of the vine, and as one might

have imagined, whenever there is anything good to have, Weevils are sure to be to the front. Two kinds are shown in the illustration, *R. betuleti* and *O. sulcatus*. The latter is the commonest and is about $\frac{1}{4}$ inch long and black, with yellow hairs. It is unable to fly. The grub is creamy white, with brown hairs and the pupa of the same colouring. The eggs are laid in the summer months in the earth near the roots of the vine, wherein the grubs gnaw and tunnel about, feeding on the tender, succulent parts during the whole of the autumn. Adult weevils emerge, the following spring, and subsist upon the young leaves, for it must be remembered that, as is the case with so many beetles, the parent insects are often quite as harmful as the hungry grubs themselves. Most of the Coleoptera have a very businesslike mouth and jaws, as contrasted with, say, the butterflies and moths, which are haustellate, i.e. when full-grown have merely a tubular proboscis with which they suck the honey from flowers. Again, the beetles are a long-lived race, whereas butterflies have only a short existence, except with those kinds which hatch out in the autumn, go to sleep in some old barn during the winter, and come out with the first warm days of spring to breed and die.

The Vine Weevil, when disturbed, feigns death; it is a difficult insect to kill; fumigation, unless drastic such as cyanide, has little effect upon it. This creature can also withstand almost any extremes of heat or cold. It may be frozen as hard as a pebble and thawed back again as many times as you like, but the old-fashioned remedy of shaking them off and dropping them into fiercely boiling water is simple and certain. As the Vine Weevil cannot fly, its ingress into a greenhouse must be by way of doors or window-sashes, and a sprinkling of naphthalene at these points and the use of fresh creosote at suitable times will ward them off. If they are already in the soil, and the plant is badly attacked, soil dressing and a constant look-out for the adults is necessary, and boiling

water as above. Wherever weevils are found in any number, advantage may be taken of their "lie doggo" propensities by shaking them into a cloth or umbrella and gathering them up for destruction. (See Plate 24.)

A beetle known as *Anomala vitis* feeds upon the soft tissues of the leaves of vines. It is, however, more common in the south of Europe than in England, and is related to the sacred Scarab, formerly worshipped by the Egyptians, drawings of which may be seen on Cleopatra's Needle. The insect is only about $\frac{1}{8}$ of an inch in length and behaves very much like a weevil. Its larva lives in dung. The same treatment as for weevils applies.

Another small beetle, *Eumolpus vitis*, attacks the roots and causes injury which at times prevents the formation of new shoots and may even kill the vine. It is about $\frac{1}{6}$ of an inch in length. The vigilance which will be exercised to keep out the weevils will also upset the calculations of Eumolpus. (See Plate 24.)

Two remaining beetles which attack vines are the Cockchafer and the Wireworm. In greenhouses these should be successfully combated by the cleansing of the soil by renewal each season, and the entrance of the May-bugs prevented by the use of gauze window coverings which are employed also as a bar to the entrance of birds and wasps who come after the fruit.

We now pass to the Lepidoptera, where a varied if not very distinguished company awaits our attention. All of them are moths. First there is the Gothic (*N. typica*) which is a leaf-eater. Its caterpillar has the rather unusual habit of commencing life as a tree-feeder and later on descending to feast upon winter greens and low-growing herbage generally. The moth itself occurs in June and during the breeding season, which may be extended over two months, lays eggs on the underside of the vine leaves and other fruit foliage. During their youth these caterpillars are gregarious, arranging themselves in a curiously formal fashion side by side as they

eat away the outer cuticle of the leaf, which withers in consequence. At the end of the autumn, when foliage gets scarce, they separate and proceed to establish themselves on docks, plantain, etc., as well as on cabbage and other green crops. They are about 1¼ inches long when full-grown, pale brown in colour, smooth, with a shiny head. The pupal change takes place in the late autumn beneath the ground. We are here concerned with the caterpillar in its youth, and by far the best remedy is egg search, but failing that, spraying with carbolic soap emulsion should induce the marauders to make tracks for the jungle outside at an early stage in their career. The moth measures 1½ inches across the fore-wings, which are delicately marbled in grey and brown, the hind wings being of a uniform grey colour. The body is stout, as with most Noctuid moths, of which this is one, and the antennæ are long, slender and pointed. There is little to distinguish between the sexes in outward appearance. The male may boast of the little bit of fringe on his feelers, but, like the moustache of the pre-war weak young man, a magnifying glass is necessary in order to see it.

The White Line Dart (*A. tritici*) is another common moth which has been known to damage both leaf-buds and leaves of the vine, in common with the Yellow Underwing Moth, which has been dealt with in Chapter III as a pest of the Lettuce. Both these insects are usually root-feeders, but vine-leaves are also eaten. The White Line Dart measures 1¼ inches across the fore-wings, which are dark brown with paler brown and white markings. The hind wings are whitish at the base, where they join the thorax, and have a smoke-coloured border. The caterpillar of this moth is smooth, mottled brown on top, the sides being dingy green with a pale grey lateral stripe. The moth appears in July and the eggs are laid at the end of the month, larvæ feeding from the middle of August until the end of the season, when they pupate in the soil. Egg search on the leaves

and digging up the pupæ from the roots are the best methods of checking these moths. (See Plate 25.)

The Ermine Moth (*S. menthastri*) is still more common and more troublesome. Everybody has seen this woolly, extremely active caterpillar, which is conspicuous on every leaf throughout the day and yet manages to bolt out of reach at the first sign of danger. Entomological books will tell you that the White Ermine larva is common everywhere and eats everything, generally low herbage. But although quite true, this is scarcely definite enough, and it certainly ought to be scheduled as a vine pest. I have noticed, particularly in London and the suburbs, that this larva, and also that of the Buff Ermine (*S. lubricipeda*) which is very similar, but of a richer, darker brown, are addicted to grape vines, as much in the open air as under glass. The first brood of moths hatches out in May and lays eggs on dock leaves and other weeds, where the young caterpillars feed in company for a time and then wander off singly, often to great distances, and feed on anything good that is going. It is surprising how they get into the places that they do, establishing themselves with ease, if not grace, in greenhouses and among pot plants, or when changing their skin or about to pupate, they even take possession of our house and home. With regard to vines, spraying will not injure Ermine larvæ, and they must be shaken off into a cloth or umbrella, picked up with gloved hands and dropped into a jar of salt or alum water. The web-like cocoons, found in corners of rooms or nooks and crannies about greenhouse or garden, should be destroyed whenever seen. The natural enemies of the foregoing moths are usually Dipterous or two-winged flies, but there is no practical method of employing these to our advantage. Owls and bats, however, should be encouraged, as they hunt down and devour considerable numbers of night-flying moths. (See Plate 25.)

A small Tortrix moth, *C. ambiguella*, is also a leaf-eater

on vines. The Tortrices, although a minor group of moths, often make up for their size by their prolific rate of increase. It does not follow that because a moth is small in size it can be ignored. In fact it is just these diminutive creatures that are apt at first to be overlooked, and which in many cases do the damage we are least able to cope with, more especially because it is not seen until it is too late. To the difficulties that attend their study is due the fact that the history of these tiny insects has been rather neglected, so that there is always the chance of the horticulturist and the food-grower discovering something new to science if they will go to the trouble of boxing and observing strange little insects whenever an opportunity occurs. (See Plate 25.)

These very small moths are called by the entomologist Microlepidoptera. Their life stories are exceedingly interesting and diverse, as much so as those of beetles.

In the Tortrices we have those moths which roll or twist up the leaves and buds of our fruit and forest trees, or lay their eggs in the calyx of the flower in order that the grub when hatched may work its way into the fruit and feed out of sight. We have already seen one or two examples among the Orchard pests. The word Tortrix simply means "twister" (i.e. leaf-twister), a name which aptly expresses their general habits. Then there are the Tinea, among which we get the Clothes Moths on whose account so much naphthalene and camphor has to be purchased to protect our woollen attire, furs, feathers, etc. The Deltoides or Snout Moths, so-called on account of the extremely long palpi which cover the proboscis; the Pyralides or Meal Moths, which worry the miller; the Crambites or Veneers, among which we find the insect which bee-keepers have cause to remember, viz. the Honeycomb Moth (*C. cerella*), are other groups. Finally there are the Pterophori or Plume Moths, whose wings are so split up that they look like feathers and are quite devoid of any covering membrane.

As will be realized, it would be impossible to take even the briefest survey of all these families here, considering that the labours of Henry Stainton on the British Tinea alone have filled thirteen good-sized volumes, although any one of the "micros" may turn up in full force under favourable conditions when we least expect it. Our best plan is to watch their methods and break the chain at the weak spot. If it is a leaf-miner, spray the foliage early enough, when nearly full out, and so kill the first brood as it hatches. If it is a "twister" gather up all the nests with the greatest care and burn them. If it is a fruit eater, clear out pupæ from chinks of bark and under the soil, and so forth.

The Vine Tortrix, *C. ambiguella*, already referred to, first appears out of the chrysalis, which lies in crevices of bark, in springtime, fluttering about and seeking the young buds on which to lay its eggs one by one. The caterpillars spin several flower-buds together and gnaw them about, soon passing on to another cluster, thus doing great damage. They feed for about a month, and then in June spin up a cocoon, from which they hatch out as moths a fortnight later. (See Plate 25.)

Now begins the worst injury, for the second brood attacks all the unaffected fruits, laying eggs on the stalks, the larvæ boring into the grapes and thereafter behaving much like Codlin moths in apples. The second pupation takes place in among the loose bark where they pass the winter. Spraying with caustic potash and careful removal of convenient hiding-places is the treatment. The moth itself is, like most Tortrices, a dainty little affair, about $\frac{3}{8}$ inch across the fore-wings, these being creamy buff with light sepia markings, and with a broad band, almost black, tapering down from the front margin. The hind wings are white with smoky grey outer margin, beautifully fringed.

Not to be diverted with the beauty of the moth, we must keep busy with potash and scraper if we wish to

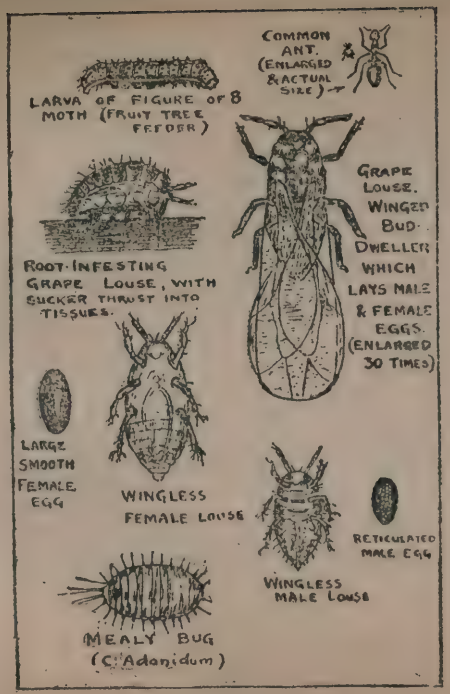

PLATE 26.
Further Vine and Greenhouse Pests.

PLATE 27.
Tomato Canker and Eelworm.

keep it in check. The eggs are microscopic in size and it is hardly likely that much can be done in searching for them. But the presence of the larvæ in springtime is evident enough, and all silken webs should be removed and burnt. As regards the second brood, their presence in the grape is betrayed by a blueish spot on the fruit, so that an endeavour should be made to cut off the second generation as early as possible, even though it may mean considerable loss of grapes in that particular season.

Passing from moths now, we find the grape vine is subject to attack from certain of the Hemiptera. For instance the Grape Scale (*Coccus vitis*) and the Mealy Bug (*C. adonidum*), relatives of the famous cochineal insect of commerce. They infest the bark, and both may be disposed of by painting with methylated spirit or turpentine. (See Plate 26.)

Neither of these pests are so deadly or serious, however, as the terrible Grape Louse (*Phylloxera vastatrix*) which belongs also to this order of insects, and it will be worth while our studying this pest a little more closely.

As in the case of the Aphids, of which a variety (*A. vitis*) of course turns up on vines and should be met in time with the spray, *phylloxera* presents a remarkable and even more elaborate scheme of reproduction than its relative ; to which cause, by the way, we may ascribe the firm hold it has upon a vine house once it gets itself established. (See Plate 25.)

The details are as follows :—Vine Lice may be root-feeders or leaf and bud eaters, both kinds being produced from the same female. The reproduction scheme is complexity itself. There is a great-grandmother, wingless, who has two distinct classes of offspring, viz. root-infesting like herself, and winged leaf-eaters whose mission is to carry on the " good " work above ground. Both these children are females, always. The first can continue to reproduce females, all root-infesting and all wingless. The second produces a wingless female and this time a

male, wingless as well. It seems rather late in the day for paterfamilias to turn up, in the third generation, but apparently they can carry on within certain limits without him altogether if need be, as they go in for what we call parthenogenesis or virgin reproduction. The result, however, of the appearance of the male on the scene creates a diversion, as we might expect, and at this stage the winter egg is produced, which the parent louse deposits on the bark and colours so artfully that it cannot be seen. These eggs carry the species through the cold months. In April they hatch into a " stock-mother " who creeps up the branches and into the buds, where her sharp proboscis sets up a gall-like swelling within which she establishes herself and brings into being some 200 children, all females, but some are bud-dwellers and the remainder take after the original root-infesting great-grandmother once again. Thus the " grand circle " is complete, in the sixth generation from the commencement. I hardly think there is a more wonderful story in the whole of the animal kingdom, nor a more tenacious method of ensuring the continuance of a species. Hence the difficulty of eradicating *phylloxera*. In bad cases Vines must be uprooted and burnt, the soil removed and the house fumigated by the cyanide process.

The power of these parthenogenetic females to reproduce, does, after a time, diminish, and thus the arrival of the male certainly adds vigour to the race. It is evident that the sex problem among the *phylloxera* is in a very rudimentary state.

As regards remedies it will at once be evident that the winter egg is the weak spot at which to break the chain, if you can find it, but there's the rub. It is coloured to match the bark, but good results will be obtained by the use of one of those rust-removing brushes made of steel wires and sold by toolmakers. After this caustic potash may be applied.

I might mention that a single stock-mother, com-

mencing in March, can be responsible for 23,000,000 descendants before October is out. The insect was first brought from America, has been known in English vineries since 1865, and is now common enough throughout the world.

The Hymenoptera are chiefly represented by the Common Wasp (*Vespa vulgaris*) and the Hornet (*V. crabro*) against which nest-destroying campaigns are familiar enough throughout the country.

There is, by the way, a friendly genus of Sand-wasps, which live in walls and dry places, *Odyneri* by name, which go hawking after weevils, pouncing upon them, stinging them to death and carrying them away bodily as food for their young. The *Odyneri* are easily distinguished from the common wasp as they have no yellow belts across the abdomen. (See Plate 24.)

I should have mentioned also that there is one count in favour of millepedes in that they feast upon the root-feeding vine louse, though most folks would think it scarcely sufficient warranty for welcoming their presence.

Leaving insects we have still to notice the Red Spider or Spinning Mite (*Tetranychus*) which has almost as much power of reproduction as the Vine Louse. It lays its eggs in between the ribs of the leaves, and the spiders are full-grown in from ten to fourteen days. Tobacco fumigation is helpful and can be done whilst the plants are in the house, other and more drastic methods, such as cyanide or sulphur poisoning, having to be arranged for when everything has been cleared out. (See Plate 24.)

Our notice of Vine pests may be concluded with a reference or so to fungi, as although outside the province of this chapter, they are often as troublesome as insects to the grower.

First there is the Powdery Mildew of the Vine (*U. spiralis*), a plant parasite which is supposed to have come over from the United States, where it occurs as a natural ailment on wild grape as well as on cultivated forms.

The fungus appears as a delicate white powder in patches on the tops of the leaves and also on young shoots and fruit. Spraying with potassium sulphide should be repeated as occasion requires and all diseased leaves and fruit collected and burnt. Dust with flowers of sulphur also. (See Plate 25.)

Then there is White Rot, which eats its way into branches and fruit. This fungus never attacks foliage. Bordeaux mixture will effectually deal with it, as many folks have noticed in the wine-growing districts of France and Italy, where bunches of grapes may be seen coated with the blue "verdigris" which to the uninitiated looks at first as though the remedy were really the disease. It is washed off quite easily.

The greenhouse is capable of providing us with the much-prized green figs in England, whilst the pine-apple itself is the perquisite of those who can afford to spend a sovereign to get half-a-crown. Pines of course are also grown in special pits on a hot-bed, but they are very costly to produce. Both crops are subject to Mealy Bug and White Scale, which can be met with kerosene emulsion, done before fruiting time. The above remarks also apply to fruit trees such as peaches, apricots, oranges, mulberries, nectarines, etc. On all these trees a lookout should be kept for Tortrix moths as well as for scale and aphis. The Figure of Eight Moth, described in the last chapter, is also likely to turn up, and I give a drawing of its larva for identification on Plate 26.)

Next we come to cucumbers. Here are Aphis again, as well as Red Spider. Thrips also occur, all of which have been treated of. Woodlice also give trouble unless rigorously routed out, and it is hardly necessary to say any more about that.

The Canker (*M. citrullina*) attacks cucumbers, melons and greenhouse tomatoes. This fungus betrays itself by a greyish white sickly appearance of the stems of the plants, which may often be killed outright. It is one of

the penalties of introducing an artificial state of things such as obtains in a glass house, and the moist and warm environment is essential to its development. Spraying the plants with liver of sulphur will prevent the spread of the disease, and those plants badly attacked should be pulled up and burnt. The Board of Agriculture has to be notified whenever this fungus appears. (See Plate 27.)

Another disease of Cucumbers and Melons is *Cercospora melonis*, better known as Leaf Blotch. It presents the appearance shown in the sketch, the spots being pale green at first and increasing in size gradually, turning grey and then brown in colour. If these brown spots be examined with a strong magnifying glass, a tiny forest will be seen, where the trees are the minute stalks of the fungus, and the fruit are the spores which drop off when ripe and blow about to carry on their work elsewhere. Why do fungi come in this way and spoil our crops ? It will be found that in most cases it is pale, ill-grown, emaciated plants which are predisposed first of all to get the fungi, and the occurrence of the latter is simply a case where Nature steps in, by her agent, to destroy such plants. What we have to do is to prevent the healthy plants getting infected, mainly by removing all weak stuff, and as a precaution using an emulsion of soft soap and potassium sulphide. (See Plate 28.)

It has been noticed in the case of cucumber and melon leaf blotch that plants removed to the open air lose the fungus and put out new foliage, thus indicating that the disease has been induced purely by the artificial conditions existing. We should therefore remember that too rapid growth at the expense of robustness is a dangerous course for ourselves and our neighbours.

Root Knob Eelworm is also liable to attack cucumbers and tomatoes. See remarks at end of chapter on orchard pests. The roots assume the form shown in the sketch, the first symptom being a dropping and withering of the foliage, followed by limpness and collapse of the whole

plant. The knobs shown contain the young eelworms $\frac{1}{75}$ inch in length, which increase in size until they become pear-shaped. They then lay eggs on other parts of the root or on a fresh plant and re-assume their worm-like form. Soil infested badly must be saturated twice in carbolic acid solution on two successive fortnights, and left to sweeten out for at least six weeks. Gas lime is employed as a second remedy. It should be noted that clover, grasses and many weeds and other plants act as intermediary hosts for the preservation of eelworm, which fact will account for its appearance where it could not have been otherwise explained. (See Plate 27.)

In all these fungoid diseases half the battle in avoiding them consists in the scrupulous cleanliness spoken of at the beginning of this chapter, and before re-stocking a house a fumigation of sulphur is a good thing as an absolute fungicide.

We may conclude our chapter with the White or Snowy Fly, a hemipterous insect known to science as *Aleyrodes proletella*, which is of common occurrence both inside the greenhouse on tomatoes, cucumbers, etc., and on cabbage and other crops out of doors. See remarks in Chapter III on cabbage pests. In houses the blight may be removed with tobacco fumes. (See Plate 14B.)

Some people think that Ants (Formicidæ) are a great nuisance, though I cannot see why, except in the case of the little House Ant (*F. domestica*) which gets into cupboards where jam and honey are left uncovered.

The main business of the yellow and the black ants which we find in greenhouses crawling up the stems of the plants is to hunt for small beetles to eat and aphides to "milk" of their honeydew. Loosened paths and spaces behind shrunken skirtings in old structures afford them house room. Naphthalene and sealing up such spaces with putty will do what is wanted. (See Plate 3, Fig. 5, and Plate 26.)

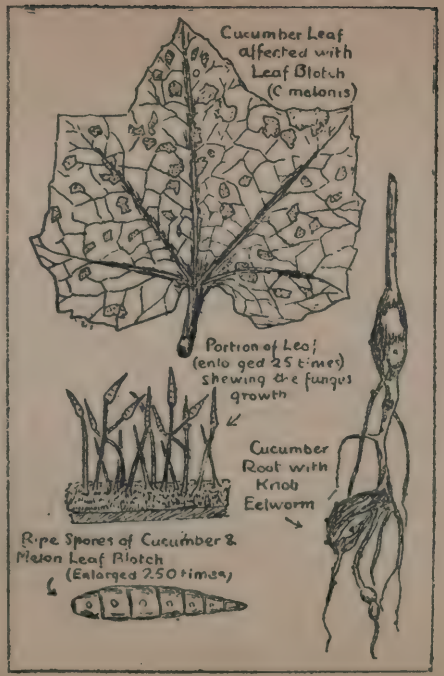

PLATE 28.
Cucumber Leaf Blotch and Knob Eelworm.

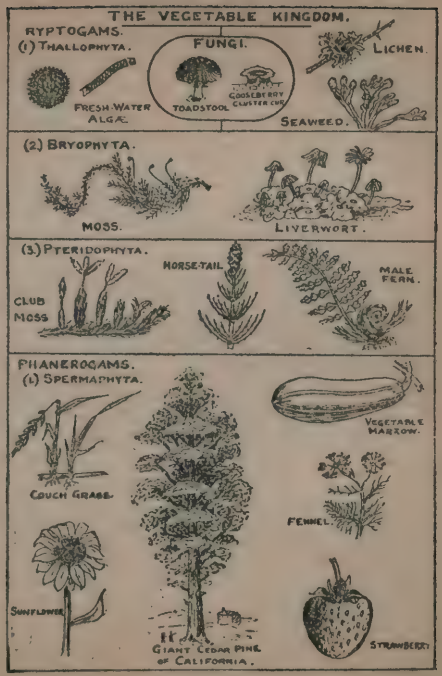

PLATE 29.
Diagram of the Vegetable Kingdom.

CHAPTER VII

FUNGOID DISEASES OF PLANTS

Important and peculiar position of Fungi in the Vegetable Kingdom—What is a Fungus ?—Method of reproduction—Conditions favourable to the development of parasitical fungi—Means of checking their action—Potato diseases—Club root or Fingers and Toes—Heart rot of Mangolds and Swedes—Bean and Pea Fungi—Celery and Parsley Leaf Spot—Clover Sickness—Corn Fungi—Onion Fungus—White Rust of Cabbages—Gooseberry Mildew—Cankers and Apple Diseases—Strawberry Leaf Spot—Raspberry Disease—Silver Leaf.

THE question of fungoid diseases of plants is not strictly speaking one that comes within the province of an insect book. At the same time, as we have seen in the case of the Vine and other greenhouse subjects in the last chapter, the grower is bound to find both insect and fungus pests in close proximity even though they may not be in any way associated with one another.

For this reason therefore it has been thought advisable to take a few of the more prominent examples of fungi which attack and destroy crops and fruit, and give a short outline of their life history and some suggestions as to the best way in which to combat their activities.

To begin with, we may very well ask, what is a fungus ? We can answer this question best by looking at the position in life which fungi occupy, and as it is a peculiar one it will be worth while examining it a little closely.

Briefly, then, the Vegetable Kingdom is divided up

into four great Orders of Plants, as follows, commencing with the lowest:

Cryptogamia or Concealed Flowers.	1. Thallophyta. Simple, cellular, flowerless plants, including all the Sea-weeds, Algæ, Fungi and Lichens.
	2. Bryophyta. Simple flower-bearing plants, such as Liverworts and Mosses.
	3. Pteridophyta. Spore-bearing plants whose fructification is on the underside of the leaves or fronds; examples, Ferns, Horse-tails, and Club Mosses.
Phanerogamia or Visible Flowers.	4. Spermaphyta. Flower and seed-bearing Plants embracing all Grasses and Cereals "Flowers," "Vegetables," Herbs, Bushes and Trees.

Now it might perhaps appear from this list that the first three Orders of Plants described were almost a side-show compared with the last, where we seem to have roped in practically all that is generally meant by the word vegetation. This is by no means so true as it seems, however, as the algæ and fungi, which, according to our arrangement, belong to the lowest order of plants, together comprise a whole unexplored universe in themselves, which the microscope has done so much to reveal. Between the Fungi and the higher orders too, there is, as we shall see, a great gulf fixed. Now it is amongst these minute plants or plant organisms that many of our common diseases are found whether it be an animal or plant ailment, and so we shall do well to just glance at the details of fungus growth before speaking of the particular examples given in this chapter. (See Plate 29.)

Although fungi belong to a lowly order, they are part of a very important group, the species of which far outnumber the higher plants, and are still insufficiently known. What is a fungus like? The word comes from the Latin and means mushroom, that favourite esculent, the form of which, with the toadstools and puff-balls, is familiar to all. But take, for instance, that curious

kind of growth which comes on a piece of Cheddar cheese in the unlikely event, in these days, of its being left in a damp cellar and forgotten. Here we shall see a sort of blueish green fluff. Under a magnifying glass this fluff will be seen to consist of extremely delicate filaments. These are as much fungi as are the mushrooms and toadstools. In fact we will go the whole hog and give it its proper name, *Penicillium glaucum*, but for the rest of this chapter I shall fight shy of botanical names as much as possible, as these are well calculated to break any printer's fount of type, and are rather a clog to the general reader. Some day let us hope that botanists will be able to simplify their nomenclature, which varies too with different authorities, but the secret is simple enough as a rule once it is unlocked.

The fungi in the foregoing table are divisible into five sub-classes, viz. the Carpomycetes, or mushroom and puff-ball fungi; the Oomycetes, or parasitical disease fungi; the Zygomycetes, or mould and mildew fungi; the Myxomycetes or slime fungi; and the Protomycetes or first fungi, including yeast: the affix-mycetes, so common in this order of plants, coming from the Greek word μύκης, *mukes*, a mushroom.

Fungi as a group are totally distinct from all other plants, even the seaweeds and lichens in their own order, by reason of one vital property, which forms an absolute line of demarcation between them and the rest of the vegetable kingdom, in that they contain no chlorophyll. Chlorophyll is the green colouring matter which characterizes all other plants. It *may* be disguised, as in copper beech or red seaweed, but is there all the same. This substance, which under the microscope usually takes the form of a spiral ribbon within the plant cell, performs the highly important function of extracting sustenance from sunlight and air, and mineral substances in the soil. Now the main difference between an animal and a plant is that the former cannot live on minerals

alone, even though they be chemically identical with the vegetables that *will* support it. If this were not so the tabloid lunch would be a "standing dish" in the City to-day. But we human beings, like the rest of the animal creation, are supported by the assimilation of carbon, iron, salt, etc., and above all *starch*, so that calling us a stiff-necked generation has more in it than meets the eye. But we must have these things in a bulky and vegetable form, meat of course and fish being merely a transmuted vegetable. We require them bulky because the walls of our stomach are not happy unless they are distended, not to say gorged, although many a small boy may have long views on that score. We also require these things in a vegetable or other organic form because we could not digest their equivalent off the chemist's shelf.

It is clear then that it is the chlorophyll in all plants, except fungi, which enables the whole fauna or living creatures on this earth to "carry on." Except fungi! That's just it, and as we saw in the beginning of Chapter III. as regards insects, here we have another case of the obscure and unnoticed parasite carrying on work which is vital to our future and may be even shaping our destiny, for fungi, containing no chlorophyll, are obliged to subsist upon organic matter either living or dead. Those fungi which feed upon decaying tissues really perform the function of removing agents, for they transform them once again into their original elements, but the fungi which support themselves upon a living plant or animal are inimical and therefore come under the head of pests and diseases. These, as indicated above, are, without appearing to do so, very often in control of the situation, if not actually ruling the roost.

We see, then, that fungi are a plant group which stand quite by themselves, the species, through being devoid of chlorophyll, being compelled to subsist either upon another living organism or upon something which has lived before.

PLATE 30.
Some Common Fungi.

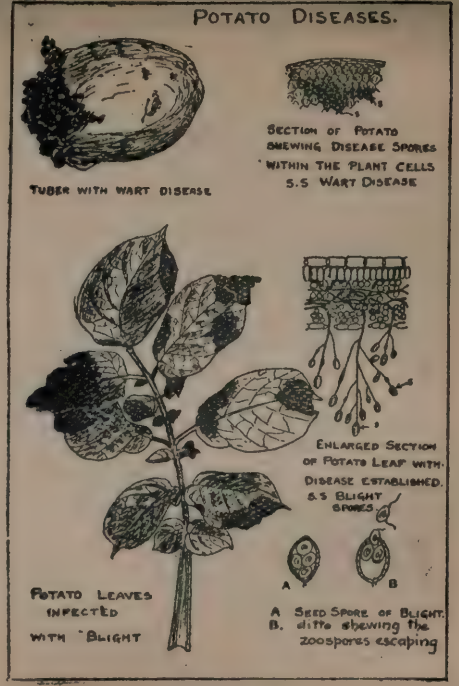

PLATE 31.
Wart and Blight in Potatoes.

This is where their importance comes in from the grower's point of view. Take, for instance, the common Potato, *Solanum tuberosum*. This plant is really a native of South America, which has been introduced into most other countries during the past four or five hundred years, a relatively short period in the scale of evolution. In England the almighty "spud" is able to continue its growth during about seven months of the year, when it has to be protected from the rigour of the seasons. If only that were all the position of the "spud" would be fairly secure, as long as there were human beings to store and protect it, even though it might never become a native plant. But at this point another party has something to say, one *Phytophthora infestans*, who has strong views, backed up with the power to see them respected. *P. infestans* comes along and says, "What, *Solanum* here! Not if I know it." Away he goes to release his millions of invisible agents, and good-bye to your potato crop by the time *Phytophthora* and the like have done their fell work.

The potato, however, is only one of the plants which have to suffer from the attacks of fungi, and to meet these we must apply the same principles to the management of our crops as we have seen to be necessary in the case of insects. In a word let us find out where to break the chain of development in the plant parasites which trouble us. Again we must study life histories in order to arrive at the weak spot at which to apply our check.

The life history of a fungus, although they show many variations, is somewhat as follows:

Existence commences in the form of a Spore, a simple cellular body, practically invisible, and capable of being blown about by the merest puff of air until it alights upon the host plant, where it takes root and grows. Sometimes there are two or even three host plants, all different, yet the fungi on each are merely preliminary stages in the

development of the same parasite, which having completed its circle returns to the first once more. For instance, the little red spots called "cluster-cups" on bramble or barberry was once classed as *Æcidium berberidis*, and the orange-coloured ovals found on grasses and corn was called *Uredo segetum*. They are now known to be one and the same plant, *Puccinia graminis*, or Wheat Mildew. In the full-grown fungus there is often little to distinguish between root, stem and flower, judging by ordinary standards, at least in the tiny organisms we are here dealing with. The cells are all much of a muchness, being a collection of thin-walled boxes of protoplasm, the gelatinous substance which is the basis of all life.

Some examples are shown on Plate 30 of familiar moulds and mildews, which illustrate the simplicity and yet the endless variety of fungal growth.

It will be noticed that in all these examples the main object of the plant appears to be the production of the little round bodies marked "s," which are the spores, and this is in fact the case.

These tiny, invisible spores, once released from the parent plant, from which they are often expelled with a sudden jerk, float about in the atmosphere and are wafted on to decaying matter, or on to the soil or the host plant as the case may be, until conditions favour their development into full-grown fungi to carry on the same process once more in their turn. This explains the otherwise unaccountable appearance of a fungus disease where least expected. The offending spores may have rested dormant for an indefinite period, or have been blown along by chance in the breeze.

It is always at the spore stage that we must seek to break the chain and check these troubles, as the harm is done once they germinate. How is this to be accomplished?

Now if there is one thing above all others that fungi

hate it is carbolic acid. They vanish like magic at its appearance. But so also does plant life in general! Are we able then to administer this dose in such a way as to avoid injury to the crop itself? The safest form in which to apply the acid is as an emulsion with soap and as a soil dressing on the vacant field before the plants are put in. The carbolic treatment is, however, a drastic one which need only be brought into play in very bad cases.

A much better scheme, for general use on a large scale, and which obtains the same result at less cost, is to spread the ground evenly with powdered quicklime a month or so before the plants or seeds are to go in. This has the double advantage of improving the ground and warding off fungi spores. Whence it follows that it is on the well-managed soils that plants escape these things, giving them that rapid and vigorous growth which is unfavourable to the germination of parasitical diseases.

I now propose to take a short general survey of the common fungi which attack fruit and vegetable crops. The subject is a big one, and I can only deal with it in the briefest way within the limits at my disposal.

Among field and garden crops the potato comes first. The dangerous exotic, as it has been called, is subject to some fifteen or twenty fungoid diseases in all, the most prevalent being:

Potato disease, Wart disease, Corky Scab, Dry Rot, Skin Spot, Leaf Curl, Silver Scurf and Rust.

The first-mentioned, known to the botanist as *Phytophthora infestans* and to the farmer as "blight," has the general appearance on the leaf shown on Plate 31, the appearance of the fungus itself under the microscope being also indicated.

As a matter of fact Potato Blight has had a very important effect on English history. Possibly, if it were asked, who brought about Free Trade, nine out of ten people would answer "Richard Cobden," which would

be quite wrong. It was *P. infestans*, the author of the Irish potato famine of 1845, and the consequent Corn Riots took the matter at once beyond the pale of polite debate. When people cried out, "The HUNGER is upon us," it was time to drop talking. The famine was caused by *P. infestans* alone, which swept like a scourge throughout Ireland and reduced the late crop of potatoes to one mass of putrefaction in two short weeks, leaving six millions of people to face the winter on practically nothing.

No such deadly warning had ever occurred before of the dangers of leaving a large population almost solely dependent for their food upon a risky exotic plant. At that time very little was known of the nature and cause of the Blight, but to-day, by the aid of sprayers and Bordeaux mixture, we may claim to a large extent that the "blighter" is blighted. No country, however, should at any time be entirely dependent for its sustenance upon the potato, excellent as its food value is. The only food-plant which we should pin absolute faith upon is wheat, which Homer calls "the marrow of men." If that ever fails us on a grand scale, the position of the human race at large will be precarious indeed.

With regard to the use of Bordeaux and Burgundy mixture for potato disease, it should be pointed out that these remedies cannot CURE, they are only a protection against attack. Hence the crop must be carefully watched and the spraying must be done in time. It should be started at the end of May for earlies in the West of England, in the middle of June for late crops there and in South Wales. In a word, follow the season wherever you are. The "Riviera" counties and the Sunny South want it before the end of June, London and the Home Counties by the middle of July, and further north before the end of that month, in all cases as soon as the leaves and haulms are well developed. It must be repeated at times in the event of heavy rains.

The Wart Disease or Black Scab of potatoes is more

serious and difficult to handle than the Blight where it gains a hold and is due to a fungus known as *Synchytrium endobioticum*. It lives as a parasite within the cells of the potato, the cells being stimulated into active subdivision much like Club Root of turnips, the tubers being entirely destroyed. Here again we are in the hands of the invisible spore, which may remain dormant in the soil for years; it may be conveyed on the boots of the grower from one place to another; it may be dropped by birds, or it may pass harmless through the body of a pig if the animal has been fed on the spoilt tubers, which latter by the way is a criminal offence.

It has been said that Wart Disease is the most difficult of all diseases to eradicate from the soil. This is mainly for want of a cheap method, but in a bad case over a small area the carbolic treatment should be effectual. As stated above, the pest can come in so many ways, and is most likely in the seed-tubers when planted, so that disease-resisters should always be chosen wherever it has occurred. Among earlies these are King George, Great Scot and Conquest. Among lates try Abundance, Admiral, or Langworthy. (See Plate 31.)

Corky Scab (*Spongospora subterranea*) is a milder disease of potatoes, more prevalent in the wetter parts of the country. It is usually confined to the outer skin, but in severe forms penetrates the flesh and becomes a canker. Steeping the seed if affected in a solution of formalin (about a dessertspoonful to a gallon of water) will clean it, and as regards soil, it should be ascertained whether there is an excess of lime, which, as it happens, favours this particular fungus. If so sulphate of ammonia should be applied.

Dry or Winter Rot of Potatoes, caused by *Nectria solani*, happens when the tubers are insufficiently dried after storing, with the result that they shrink and collapse, becoming in a short space of time a culture ground for other fungi. Kainit, if it can be got, is a good artificial

to use on soil that has produced tubers which have dry rot. This fungus also attacks tomatoes, and the spores will germinate off one crop on to the other. Hence neither should be put in on ground where in the case of the other it has just occurred.

Minor diseases of Potatoes include Skin Spot, little round blotches on the tubers which are sometimes mistaken for the Blight itself. Leaf Curl, a curious affection, is somewhat widely distributed. It has the effect, in bad cases, of choking the passages in stem and leaf and so preventing the flow of nourishment from the soil. Early lifting and dressings of kainit are recommended. Silver Scurf is an affection of the outer skin caused by *Spondycladium atrovirens*, and it may be kept in control by using a little flowers of sulphur for storing purposes. Rust, which produces the brown spots on the leaves of both potatoes and tomatoes, is sometimes very active as a fungoid disease, but its control may be achieved by the timely use of Bordeaux as in the case of Blight.

The curious ailment of Turnips and allied crops, which has been named indiscriminately Fingers and Toes, Club Root, Anbury, and Grub (which latter is an erroneous confusion with the work of the Turnip Gall Weevil), was once thought to be a physical trouble of the plant itself, but has now been located as an internal fungus called *Plasmodiophora brassicæ*. I must apologize for these long names, but they are the only ones which have specific fixity. Fingers and Toes also attacks swedes, cabbages, kohl rabi, radishes and common weeds of the cruciferous tribe. The fungus is only visible under the highest powers of the microscope. A turnip cell is shown in the illustration filled with the spores of this disease, which causes the cells to expand and so distort the root of the plant into all manner of grotesque shapes. The spores have the power of lying dormant in the soil for years if necessary, and as soon as they come in contact with a suitable subject, to which they fasten themselves,

they soon penetrate the tissue to commence their cycle of life again. Lime is fatal to the Fingers and Toes disease, and the ground should therefore be dressed with ordinary slaked lime, powdered and spread evenly. This is better than the ground lime sold, as it is cheaper and contains no impurities. (See Plate 32.)

The Heart Rot of Mangolds and Swedes, and of Sugar Beet, is not so common in this country as in France, but cases have been known of a whole field with every root badly infested. The fungus, *Sphaerella tabifica*, germinates first on the stalks and upper part of the plant, the leaves wilting, and finally penetrating the crown of the root, where the work of destruction goes on out of sight, leaving the interior an ugly black decayed mass. On no account should diseased roots be left long about or fed to animals, but burnt to ashes as soon as possible. Red Beet is hardly ever attacked by this disease, and may, therefore, be grown where this fungus has occurred.

We now pass to Beans and Peas. These crops, as we might expect, have been specially adopted by particular species of fungi. (See Plate 32.)

Bean Rust (*Uromyces fabæ*) is familiar enough. It occurs on both broad and runner beans, and takes the form of a leaf spot as shown in the sketch, the fungus itself being a collection of simple egg-shaped cells. Two kinds of spore are shown, much enlarged, representing two stages in the growth. Spraying does not injure this fungus, and all bean haulm should be watched so that diseased portions may be at once burned. The compost heap is very valuable to the grower in these days, but every care should be taken that it is not allowed to become a fungal nursery.

Scarlet Runners and French Beans suffer more severely from Pod Canker, *Colletotrichum lindemuthianum*, than they do from Rust. It makes its first appearance on the pods in the form of dark patches, which indicate the presence of the rooted spores. These soon cause the

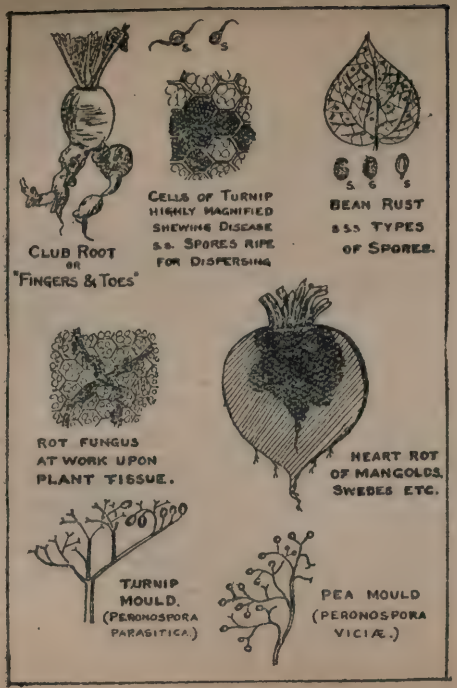

PLATE 32.
Turnip, Mangold, Pea and Bean Diseases.

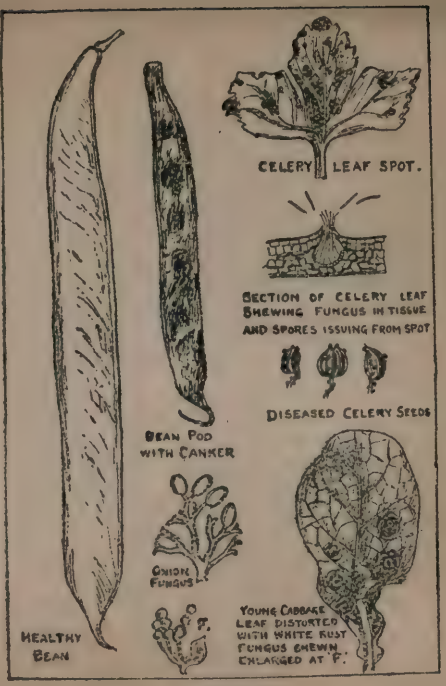

PLATE 33.
Bean Canker, Celery Leaf Spot and Cabbage Rust.

bean to become stunted and withered, as the fungus eats its way into the plant tissues and prevents the ripening and fattening of the pod which is desired. Bordeaux mixture at half strength or liver of sulphur mixture (1 ounce to 4 gallons of water) until the pods are half grown will ward off this trouble. The sketches show an affected and a healthy pod respectively. (See Plate 33.)

Peas are subject to Mould or Mildew, caused by *Peronospora viciæ*. The figure shows a highly magnified view of this parasite, which presents under the microscope a not unattractive appearance. To the naked eye it is a dirty grey bloom on the pods and is not likely to be much appreciated, as it is the cause of the yellow and wilted leaves and pods that deprive us of many a choice dish at the time of year that calls up memories of Aylesbury duck. (See Plate 32.)

There are numerous other fungus diseases of Peas, all somewhat similar to the above. In no case is the spore carried through the winter on the seeds, and the pea, being an annual, it follows that resting-spores must find sanctuary among decayed haulm, dead leaves or wild allied leguminous plants such as vetches. The importance of this should not be lost on the grower, and all affected bines as well as "likely cards" among the weeds should be collected and burnt. Half strength Bordeaux will, however, be useful a week or so before the plants are full-grown.

The Leaf Spot of Celery comes under the head of Blight, and is called *Septoria apii*. It has been on the increase of late, on account of the augmented use of this vegetable. The Leaf Spot makes its first appearance as dirty greenish-brown spots, which soon suffuse the whole surface of the leaf and cause it to wither away. The fungus then passes down the stalks and so ruins the whole plant. As shown in the enlarged section, it behaves much like potato blight, worming its way in between the plant cells and so down to the vital parts. This explains

the futility of using the spray AFTER the damage is done. We must be there first, and then the delicate threads or mycelia of the fungal growth cannot find their way into the outer skin of the leaf. The celery seeds themselves may have teleutospores, i.e. resting-spores, upon them, whence it is advisable to steep them in a weak solution of formalin before sowing, which will kill the fungus but not the seed. Bordeaux may be used for spraying on the field, but as stated, everything depends upon the word "before." (See Plate 32.)

An allied Leaf Spot disease also attacks Parsley, and the above remarks will apply in this case also.

We now pass to Clover Sickness. Here we have a case of what looks like one disease arising from two entirely different causes. The clover yellows and withers away in patches, and this is brought about by (1) Eelworms (see Chapter IV under the head of Strawberry) and (2) the fungus *Schlerotina trifolium*. (See page 93.)

A closer examination of the affected plants will show that the eelworm trouble is distinguished by a swelling of the stalks, whereas in the case of the fungus no such swelling occurs, but dark-coloured excrescences will be found on the roots. (See sketch.) The fungus itself is shown also, curiously like so many small megaphones. A spore-bearing mycelium is also indicated, containing eight spores which will presently be released to "carry on" elsewhere. (See Plates 20 and 34.)

Carbolic emulsion or formalin solution would certainly kill this fungus in the soil, but such treatment is not feasible on a large scale. The line of action, therefore, is by way of starving the fungus out, in other words keep infected land free from leguminous crops of all kinds for some years, putting in potatoes or corn instead, and the soil will be freed.

Wheat and other cereals are often attacked by *Puccinia graminis*, or Black Rust, to which I have already referred. It begins its curious history as a spore which is released

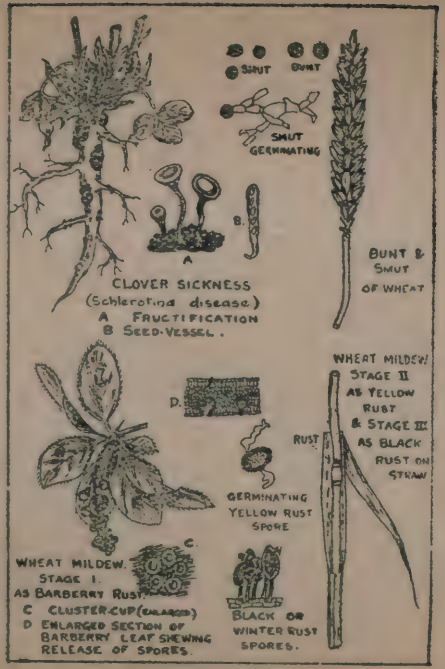

PLATE 34.
Clover Sickness, Corn Rust, Bunt and Smut.

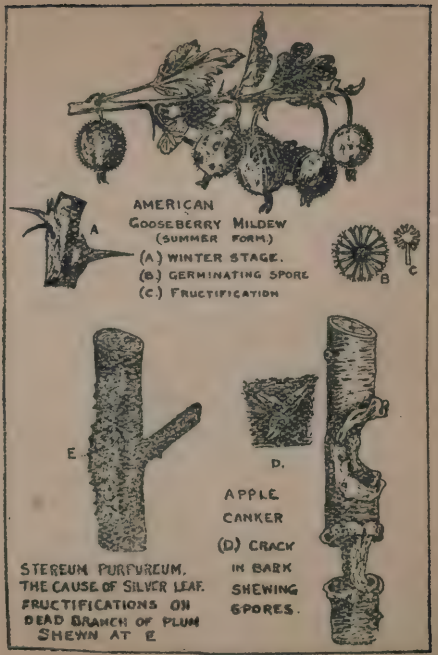

PLATE 35.
Gooseberry Mildew, Apple Canker and Silver Leaf.

in springtime from the straw on which it has been resting, and this spore will *only* germinate on a barberry or bramble leaf. Here it takes to itself a new appearance, that of the "cluster-cup," and poses as a different plant, once having claimed a different name, by way of showing what a fungus can do if it tries. As the season advances, these cluster-cups fructify, each producing a chain of new orange-coloured spores. The latter are just as fastidious about their chosen line of development as their predecessors, for they now abandon their old home on the bramble-bush, and insist upon being promoted as Corn Rust, penetrating the blades in thin lines and producing orange-coloured spores once more, this time posing as *Uredo segetum*. Finally, as the season is getting on, and it is just possible that these fancy tricks may be discovered, they think they would like to go home to roost again, so they put on their dark things and show up as *P. graminis* once more, in the form of dark lines along the ripe straw, all ready for business in another year.

Corn is attacked by several fungi in addition to the foregoing, including Bunt and Smut, which appears like grains of soot in among the ears ; White-heads or Take-all, where the corn assumes a bleached appearance ; and "blindness" of Barley and Oats, but there is no space available for these. As regards treatment for corn fungi, most farmers elect to face a certain percentage of loss each year rather than lay out money on expedients which may not save their cost. This is practical wisdom as far as it goes, but wherever a fungus has had a serious effect it would be as well to study the progress of the disease from spore to spore again, and then launch an offensive against it at the most likely period. In the case of Black Rust, for instance, the time for this, if worth while, would be just when the bramble cluster-cups are about to show up, when Bordeaux on all adjacent host-plants should arrest the thing in time. A long rotation also tends to discourage these fungi. (See Plate 34.)

Onion Fungus (*Peronospora schleideni*) is common in many districts. It takes the form of a lilac-coloured bloom on the foliage of the plant, and if attacked young the bulb is ruined. A sketch is shown of the appearance of the parasite under the microscope. Dusting with lime and sulphur is the best measure against Onion Fungus. (See Plate 33.)

Cabbages sometimes get badly deformed with White Rust on the underside of the leaves. This destructive fungus, Cystopus candidus, is common all over the world. It is really a parasite of Shepherd's Purse, on the leaves of which the clusters of spore-bearers may be seen. Where the fungus attacks the stalks of both wild and cultivated plant an ugly malformation takes place, which is a hotbed of disease for the next generation of cabbages. Such distorted leaves should therefore be systematically burned and weeds like Shepherd's Purse eradicated. This fungus thrives, like most of its kind, in damp situations, and cabbages planted in a fairly dry, open place are most likely to escape injury. (See Plate 33.)

A few examples of fruit fungi will perhaps be found of value. Among these the outstanding example is the American Gooseberry Mildew (*Sphæritheca mors-uvæ*), which in late years has devastated bush fruit in this country to such an extent that it is the subject of several Acts of Parliament, and figures as a notifiable disease under penalties for non-compliance. (See Plate 35.)

American Mildew presents two well-marked forms, the white or summer, and the brown or winter stage. In both cases there is spore-production. The summer spores are, however, delicate, and a spell of dry weather does as much as anything else to check their increase. It is the winter, or resting-spore, which is the real menace, as it can remain either on the bushes, immune from frost, or in the soil, perhaps for a year or so, and still germinate.

The greatest precautions must be taken by fruit-growers wherever this disease occurs, as the spores may

be conveyed on clothing, boots, baskets, tools, and in dozens of ways, from one place to another. Where an attack has occurred the best thing to do is to proceed to the spot with a supply of paraffin and a spray of Bordeaux mixture. Unaffected bushes around should first be sprayed as a precautionary measure, as well as the diseased ones. If it be decided that the latter are beyond hope of recovery they should then be carefully uprooted and burnt. If only a portion of a bush is mildewed, it should be cut off, covered with paraffin and burned then and there.

This mildew, as well as the European Mildew, which is as a matter of fact not so common here now as the new arrival, is always attracted by soft, quick-grown wood, especially suckers, and this fact should be borne in mind. Slow-growing varieties like "Carelass," "Long-Swan" and "Whitesmith" are therefore best, as well as "Golden Drop," which is a good sort.

Precautionary measures consist in searching carefully all plantations and gardens during summer and early autumn for signs of this Mildew. Pickers should be advised to keep a good look-out for it. Liver of sulphur should be kept in stock by the grower and applied with a spraying apparatus at the rate of 1 lb. of the liver of sulphur to 30 gallons of water. It is best freshly made.

The Canker fungus (*Nectria ditissima*) attacks the bark of young apple trees. It is unable to penetrate the unbroken bark, and hence only gains a hold through the trees or branches being bruised in any way. Hence at pruning time or when branches are removed, the wounds should be rubbed with clay or tarred over. A sketch is shown of a piece of young wood badly eaten away with this fungus. (See Plate 35.)

Two other diseases of Apples and Pears may be taken, which in their early stages might at first be taken to be the same. The leaf shown on the left is affected with Scab (*Venturia inæqualis*) which takes the form of irre-

gular patches of dark olive green on the tops of the leaves. Later on, when these leaves fall, black spores will be formed, and these will disperse and eventually find a home on the bark and fruit, specimens of the latter with the fungus on them being shown. It is only when fruit is bruised and the skin broken that Scab becomes really detrimental, or when it fastens itself on young fruit and retards the growth. The food value of the apple shown in the sketch is scarcely reduced by the Scab, but its market price, at all events in pre-war days, might be seriously altered. Bordeaux on the trees in spring will prevent this disease getting a serious hold.

The leaf shown on the right will be seen to be covered with *regular* round spots. This is the Apple Leaf Spot (*Sphæropsis malorum*), a fungus which causes also a brown rot of the fruit. The secret of spore production is shown in the microscopic section of a leaf through the middle of a spot, and as it is magnified about fifty times it will be understood how easily these tiny bodies may be wafted about from place to place. All fallen material should be carefully gathered up and destroyed, whilst Bordeaux mixture should be used where necessary in the spring, just after the petals have dropped. (See Plate 36.)

The cultivation of field Strawberries is so important in these days that a passing reference must be made of a common injury that the plants suffer in the form of a fungus called *Sphærella fragariæ*, or Strawberry Leaf Spot, which assumes the aspect shown in the illustration, the colour of the spots being first brown or reddish-brown, and later a white spot appearing in the centre of the ruddy patch. The white spot itself is bounded by a red ring, which gives this disease the popular name of Bird's Eye Spot. The effect of Strawberry Leaf Spot is to materially reduce the yield of fruit and weaken the plants for the following season, but it may be prevented by careful watching and an early spraying with either liver of sulphur or Bordeaux, to be repeated at intervals

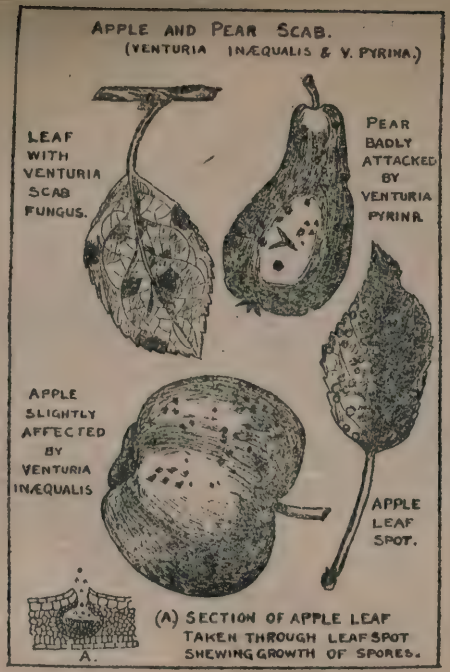

PLATE 36.
Scab Disease of Apples and Pears.

PLATE 37.
Raspberry, Strawberry and Loganberry Diseases.

until the flowers appear. Here again I would point out to the novice that it is always advisable to look at the money side of the question. It is comparatively easy to prescribe a remedy which will be effectual, but quite another matter to prescribe one which will appeal to a practical man. This may sound a bit contradictory, but a little thought will show that after all a grower's best friends are his observation and his judgment, which cost nothing, and may save him a lot of money into the bargain. But these faculties must be used constantly to be of real benefit, and guide him as to when and in what circumstances to call science to his aid. A good mechanical help on strawberry beds consists of mowing down after fruiting time and subsequently burning the dry leaves mixed with straw over the field. This has been found to add vigour to the plants and is inimical to the Leaf Spot Fungus. (See Plate 37.)

Both Raspberries and Loganberries are subject to the depredations of *Hendersonia rubi*, a fungus which also attacks wild roses, brambles and other indigenous rosaceous plants.

In both cases this fungus assumes a lurid, purplish colour at first, and then, having killed the bark, the winter aspect is grey or dingy white, the spores appearing as minute black spots. (See Plate 37.)

Infection mostly takes place on unharmed canes and wood at fruiting time, so that spraying cannot come in as a remedy unless the crop is to be sacrificed. This extreme measure must be resorted to in a bad case, and the spraying of brambles and other likely wild plants if in the immediate vicinity should be done. All canes cut down should be at once burnt.

Apples, cherries, peaches, apricots and more commonly plum trees have in recent years been subject to Silver Leaf. This is a mysterious ailment which has now been traced to an internal fungus called *Stereum purpureum*, which lives and fructifies within the wood itself.

There does not look to be much the matter with the tree in the first instance, only that the leaves, instead of being a natural green, present the appearance of a silvery sheen, due to air spaces in the tissues, the cells trying to elbow themselves away from one another, and thus the leaves soon die. Presently the branches begin to die and the tree really looks sickly. The final stage takes place within the trunk itself and results in a total loss. (See Plate 35.)

When the tree is dead, fructifications of this fungus exhibit themselves on the surface of the bark. The culprit is now exposed to view, and when young is purple in colour and tough as leather, but during a dry spell shrivels away. Wet weather, however, brings the fungus to life again and causes millions of spores to be released.

This disease cannot be combated by any such means as spraying, and consequently it is essential that a watch should be kept for it and the silvering localized by cutting off and burning the affected parts of the tree. Also, needless to say, dead wood should be at once destroyed, and dead trees, if they cannot be grubbed up, must have their stumps fired with paraffin and covered with earth. The fungus flourishes in damp situations, so that improved drainage and tillage of soil will have the effect of discouraging its activities.

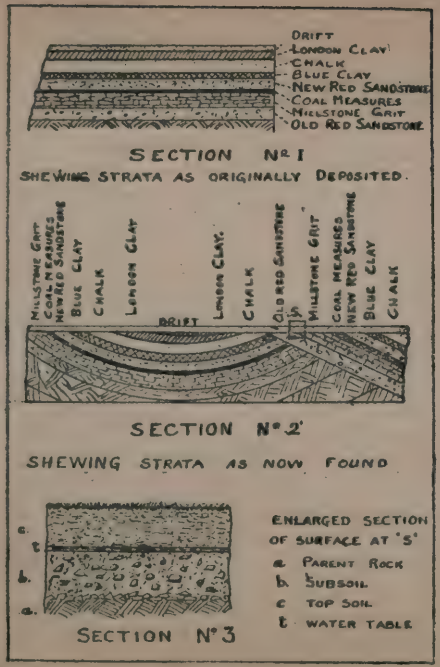

PLATE 38.
Geological History of Soil.

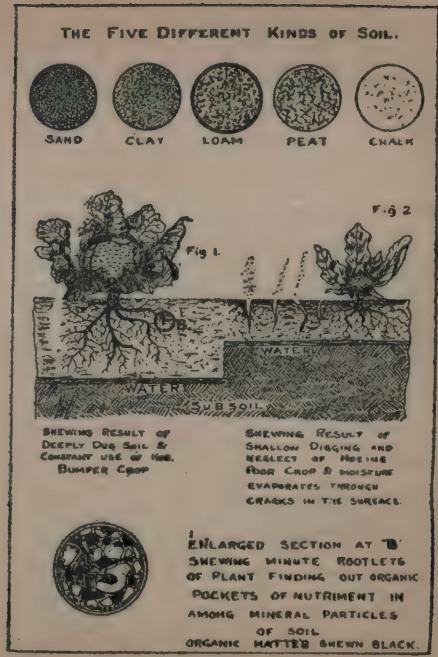

PLATE 39.
Soils and Cultivation.

CHAPTER VIII

COMPOSITION OF SOILS

Soils and their composition—How soil is produced—Conditions favourable to plant growth—Effect of drainage—Correction of texture—Difference between a good and a bad soil—How plants assimilate nutriment—Importance of humus—The action of Earthworms

THIS chapter is not intended to supplement anything that has been written on soil subjects either in the *Smallholder* or in this series of books, but to examine the question of soil purely from a naturalist's point of view. In this way I shall try to show how, if we treat the ground itself as something which is alive rather than an inanimate substance, and learn something of its "life history," we shall be best able to cultivate soil health so as to enhance the vitality of the plants which take root therein.

First of all, how is soil produced? Needless to say it would be much too long a story to tell of in a column or so of print, but we may answer the question readily enough by saying that soil is in a sense the past history of our planet. For no matter what portion of the earth's surface we take, whether it be a hard rock, soft ground, fresh water bottom or ocean bed, the indelible record of what has happened before is for ever there. Of what value is this knowledge to a grower? Of course it is not strictly necessary for him to become a geologist in order to grow corn or cabbages, but apart altogether

from the active intelligent interest which smallholders and growers as a body cannot help taking in all that concerns living things, an insight into the *modus operandi* of nature does help in catering for the welfare of the crops we are anxious to produce.

To begin with, then, soil, with a marvellous history contained in each tiny particle, consists of two main substances, organic and inorganic. Of these, the latter, the mineral portion, is the result of both chemical and mechanical processes carried on through countless centuries of time. For instance, before there was any soil as we know it to-day on this infinitesimal but highly important portion of the earth's surface known as England, there was the parent rock. We need not go into the details of the many changes from submarine to dry land conditions that are clearly indicated in any quarry cutting, as it will not help us much, and can be left to the geologist to study; but to-day, after all these various changes, through almost interminable lengths of time, certain parent rocks now lie immediately underneath our soil, and determine to a large extent the nature of that soil.

England and Wales, broadly speaking, is divided into six or seven principal bands of surface strata. Altogether our country has been highly favoured by nature, for there is a greater variety and a more complete geological sequence here than is found in any other similar tract in the whole world.

Taken in their correct order, we will commence at the Old Red Sandstone, which underlies the greater portion of the West Country, Bristol and the South Wales districts and also extends in a narrow belt right across Scotland from the Firth of Clyde to the mouth of the Tay. All these districts are orchard country, whence it is inferred that fruit growing is most profitable over sandstone.

Next we get the limestone and millstone grit, which characterizes the landscape of the Pennine Chain, and

which in itself produces only heath and pasture, but which, by means of the detritus washed down through long ages, confers on the lowlands, such as the Yorkshire vales, some of the richest soil in England.

The next item in the geological scale would be the Coal Measures, which for our present purpose we can ignore, and pass on to the rich acres both for the ploughshare and for fruit-growing, which occur above the New Red Sandstone and the Marls of the Midlands, Cheshire and of Denbigh. In the latter county the older, primary rocks have thrust themselves upwards and so formed hill-tops covered with woods and the wild uplands from which come the famous Welsh mutton.

The Liassic Measures or Blue Clay come after the Marls, and extend almost continuously from Lyme Regis to the coast of Northumberland viâ the Midlands, roughly in a straight line. This stratum decomposes naturally and gives us a fertile soil, capable of supporting a numerous population, and equally suitable for both arable and pasture lands.

Next in order comes the Weald Clay, which extends in a broad triangle between the North and South Downs, from the source of the Arun to the Channel coast between Eastbourne and Dungeness. It is of itself a stiff, cold soil, but under the influence of good drainage it becomes highly fertile, and where overlaid by brick earth we get country eminently suitable as hop ground.

The Cretaceous or Chalk deposit is characteristic of the North and South Downs themselves, and extends therefrom westwards as far as Hampshire and Wiltshire, and northwards viâ the Chiltern Hills as far as the Wash, underlying also a considerable portion of the county of Lincolnshire. Chalk hills are usually bare of woods and sacred to pasture, but the blade of the plough continues to make inroads upon it, although this kind of soil is stiff and cold as a rule.

The London Clay is last, and comparatively a recent

deposit. In fact, Lyell, the famous geologist, called this and the associated strata Eocene, which simply means "recent." Of itself London Clay is barren and unkindly as a growing medium, but as there are numerous caps of sand and gravel, and it has been highly cultivated in times past by a numerous population, it generally yields good results. The London Clay and Eocene deposits cover another broad triangle, north of the Downs this area embracing the Thames Estuary as far as Whitstable on the south side, and extending northwards along the coast to Yarmouth, the inland limit or apex of the triangle being at Basingstoke. A second area, a strip about twenty miles wide, exists to the south of the Downs, and extends along the South Coast from Selsey to Purbeck, and passing under Southampton Water, reappears in the northern half of the Isle of Wight.

Clay itself is made up of the decomposed particles of various older rocks, trap. basalt, greenstone, etc., which have been carried down and deposited at the mouths of former rivers in bygone ages and pressed together by their own weight, often embedding shells, flints, pebbles and plants indiscriminately into a solid mass. China clay, almost peculiar to Cornwall, is merely decomposed granite.

We have now seen in brief how the soil in England is founded on various geological deposits, and these are bound to affect the nature of the soil in each particular place, but we must not suppose that the rock bottom absolutely decides the composition of a soil, for many other agencies have been at work in the past, and are indeed always in operation even now. Let us study for a moment the two sections shown. No. 1 gives us the strata mentioned in the foregoing description of the rocks of England as they were originally deposited. If this condition of things had obtained we should have known little or nothing of the crust of the earth beneath us, but seeing that elevations, depressions, crumplings and out-

bursts of volcanic forces have had their say in the matter, Section No. 2 gives us a much truer view of what we should find if we turned geologist and paid a visit to some escarpment, sea cliff, or quarry cutting to-day. (See Plate 38.) It will at once be seen that the effect of the cracking up and doubling over of the various strata is to give variety to the surface which it would not otherwise have had, besides lending the geologist enormous aid in bringing up strata which he could not else have observed without very great difficulty. It will also be seen from the sketches that the top layer is the same in each case, and is called "drift." This is made up of materials, small fragments of rocks, distributed by such minor forces as glaciers and the action of rainwater and frost, the wearing down or denudation by rivers and the depositing of the scoured-away material in other places, and this drift process has given the top surface of the present world a further alteration of character.

In Section No. 3 we may observe the whole process, where (*a*) represents the parent rock, (*b*) the subsoil formed partly of decomposed fragments of the rock and partly of drift deposits. In the course of time this subsoil affords a home for innumerable generations of plants and animals, which, by their life and death and the admixture of their remains with it, are constantly forming (*c*) which we call the top soil. The shading between the top soil and the subsoil, marked (*t*) represents what is called the "water-table," i.e. the general level to which surface water percolates, and at which it drains away to lower land and finally to a river basin. If this water-table is too near the surface, the roots of plants will be injured by the damp sour soil, and thus growth will be checked. Hence deep digging will place the water-table out of harm's way, besides aerating the soil and dispersing the stagnation. Should the land be heavy, proper drainage must be ensured by the laying in of soil pipes, the effect of which will be to make the

ground healthy and the plants vigorous in growth and capable of resisting the attacks of pests or diseases. On light land little drainage is required, and its texture will be much improved by the tipping of clay on it, an operation, however, which is not a financial proposition on a large scale except in special circumstances. Plentiful dressings of dung will be wanted on all sandy soils, whereas in the case of clay, soot and lime should be given the preference, the former as a plant food, and the latter (ordinary quicklime) being used as a disintegrator to lighten the ground.

We have now seen how variety of soil is given to a country by reason of the many changes in its geological history, and how soil itself is gradually formed under the action of wind and weather and the accumulation in it of the organic remains of the countless generations of plants and animals living on its surface. Soils generally may be classified into five main divisions, viz. sand, clay, loam, peat and chalk. Peat is almost entirely decayed vegetable matter. (See Plate 39.)

Sand is the least fertile of all soils, if left to itself, and consist of the heavier water-washed particles of alluvial deposits. These particles, rounded as they are like so many pebbles on a small scale, are too loosely held together to retain moisture or afford firm root-hold for the plants.

Clay consists of the minutest particles of former rocks which have been carried away in suspension and deposited as mud at the mouths of old rivers. The smallness of these particles may be easily demonstrated by putting a little clay into a glass of water and noticing how long it remains discoloured. Had we tried clean sand it would have become transparent again at once.

This failure to precipitate readily in the case of china clay is made use of at a kaolin works, where the clay and water, termed "milk," is run through pipes to a central group of tanks, whence after the process of solidification,

it is despatched to the potteries to be turned into cups and saucers.

Clay soils by themselves are the reverse of sandy ones and hold too much moisture, which renders them cold and sour. They need much working, and as stated the admixture of hot lime to break them up. A simple test for sourness is to take a little clay in a cup and add enough water to soften it, after which a little hydrochloric acid should be poured on. If fizzing takes place, lime is there and all is well, but should there be an ominous stillness, a good quicklime dressing should be applied at once.

Loam is a happy medium between sand and clay. The beau ideal of all gardeners and growers is to have a deep dark loam to work in, a "loamy loam" as they like to call it, with plenty of humus or decayed organic matter incorporated with it. If a grower is thus fortunately situated half his work is done for him, as with all other soils constant efforts must be made to correct them and bring them as near as possible to the composition of loam.

Marl is a hardish substance, formerly a light clay and now mingled with a certain amount of lime. On the surface it decomposes, and hence when well worked marl becomes a very fertile soil. Persons travelling to the West Country for the first time must have noticed the red soil that suddenly marks the entry into Devonshire. This marl soil provides good arable and fruit ground. Marl being a hybrid soil does not strictly speaking come under a main heading, as it is really a mixture of clay and chalk.

Peat occurs where there has been an opportunity for continuous generations of plants to live and die on the same spot, thus accumulating a mass of decayed vegetable matter. It is almost devoid of lime or chalk and is as a consequence sour, requiring the admixture of the chalky element with grit to make it a satisfactory growing

medium. Peat soil is also very prone to become water-logged, and therefore attention should be paid to its thorough drainage.

CHALK, our last class, is composed of countless myriads of shells of sea animals of the cretaceous period, and wherever it may be found, whether on the top of a high hill, or in the valley, or deep down under the London Clay storing up water for our artesian wells, it is a sure sign that the sea was once at that spot. In fact the bottom of the Atlantic at the present moment is having future chalk country deposited there grain by grain, where, some day, perhaps, herds of sheep will graze and the sound of their bells will meet the listening ear. Chalk provides, as previously mentioned, a damp and cold soil, best suited for grass land, but where there is an overlay of drift we get a good growing medium, with thorough cultivation, as chalk itself, the parent of lime, is indispensable in any soil.

Both allotment and smallholders should make themselves familiar with their soil as soon as possible, and to do this it is not necessary to call in an analytical chemist. Conduct the experiment yourself in the following simple way. On a mild, fairly dry day dig up a spadeful of soil at random. Of this weigh out a couple of pounds and take it home sealed up in a tin box. Now commence the investigation. Divide the soil into two portions of 1 lb. each. Let one half remain in the box for reference. Take the other and spread it out on a flat baking tin and drive off all moisture by placing it in a moderate oven. Weigh it then on a postal balance and you get the loss by moisture. Book it. Now gather up your solid stuff carefully in a clean kitchen shovel (when mother isn't looking) lay it gently over a bright fire and heat to redness. Cool off slowly and weigh again. The loss will represent organic matter. What you want to know now is the nature of the mineral ingredients. Take them and shake up well in a large bottle of water.

Pour off the brown liquid into another vessel. The sand and small stones will be left at the bottom. Weigh them. Then take your discoloured water and filter it. The stuff on the filter paper will be clay alumina. So far so good. But when we tabulate our results we shall probably find that we are short by a small amount of weight. What about that odd half ounce? It is a highly important half-ounce, for it contains the volatile gases, ammonia, carbonic acid, nitrogen, etc., and also, as our method is only a rough one, there will be small traces of iron, sulphur, magnesia and other elements that we have missed, whilst to complete the experiment we should put our filtered water into a clean fireproof pan and boil it off to get the soluble salts which will be found as a small white residue at the bottom.

Putting the results together we are able to judge whether our soil is what it should be. Rough analyses of the three principal soils are shown below:

	Sand.	Loam.	Clay
Moisture	2 oz.	3 oz.	4 oz.
Organic substances	2½ „	5 „	2½ „
Grit	8 „	3½ „	1½ „
Clay Alumina	3 „	4 „	8 „
Volatile matter, soluble salts and loss	½ „	½ „	½ „
Totals	16 oz.	16 oz.	16 oz.

Thus we can at once see to what extent to correct the texture of our soil, always aiming at the composition of loam.

We now come to the question, how do plants assimilate nutriment? To save needless description, I propose to draw another little sketch or two, showing a plant, root and all, in the soil. In fig. 1 we see a cauliflower which is growing in good ground, well tended. The latter point is highly important, as, whether the ground be a rich nutritious loam, properly drained and dug,

sweet and full of humus, or whether it be only an empty, hungry sand which needs constant manuring to enable it to carry on even for one season; the result if we neglect to work it will be the same. Notice how the second plant at fig. 2 has been stunted by neglecting to hoe the surface and how, also, the all-essential moisture is escaping, as it does in summer time from the cracks in the surface. Where the soil is well hoed these cracks will be sealed up and the moisture from beneath will be absorbed by the top soil and not by the atmosphere. Then the plants will put out their hundreds of tiny rootlets and drink it up. Whence it will be at once realized how much better hoeing is than watering, which is a lazy man's game, and merely cakes the surface worse than ever. (See Plate 39.)

Now look again at fig. 1 and see what these tiny rootlets are doing. I have drawn one enlarged at (*b*) to show how they creep into the interstices between the mineral particles, crevices and holes in stones to find out and feed on the little pockets of organic matter, which are shown in black. This is how the plant gets most of its nourishment, the remainder coming from the air and sunlight, and also explains why plants "flag" when lifted and moved. Unless it can be done by raising a large ball of earth these rootlets, which are extremely brittle and delicate, will become detached, and the plant will remain limp and helpless until they have had time to get hold of the ground again.

Clearly then this humus in soil must be constantly renewed if we are to continue to produce plants year by year. How is this managed? The natural method, which we must endeavour to copy or employ as much as possible, is very well expressed by the words "kindly return when done with." Nature never wastes anything, neither does she exhaust or destroy, but merely changes things. We therefore, if we produce a whole lot of cabbages or corn on a field and *remove* such crop, must

pause and consider what would have happened naturally. Suppose for argument's sake the cabbage field were left to follow its own sweet will. Putting caterpillars out of the reckoning for the time, we should find most of the heads "bolt" and in due course a cloud of seeds would be borne away on the wings of the wind and by birds and other agencies, large numbers, too, falling on to the soil beneath to carry on future cabbage generations. But, and here comes the vital part, all the old plants would fall and rot into the ground, returning and indeed increasing the organic wealth of the soil from which they sprang. This fact is thoroughly grasped by the Chinese, who are the most successful gardeners on earth, and their system is to return almost daily the plant waste and manure to the soil it was derived from, and as a consequence they are able to support a very numerous population on a relatively small acreage.

Thus far we have dealt with the vegetable side of the question, but we must now pay some attention to the important services rendered by creatures which dwell in the soil.

We have already taken a peep into the lives of many insects and other creatures, friendly or otherwise, which frequent the soil. We saw that they were principally beetles, but there were also myriapods, molluscs and the earthworm. We might in addition have included the various tribes of ants which make their homes in the ground underneath the grass and growing crops. Ants as a body perform the useful function of assisting in the aeration of the soil that they are constantly working in, building and re-building the wonderful nests comprising their numerous communities. They are a very interesting study when kept in confinement in thin layers of mould between glass sheets. These enable the observer to witness the ant economy with great ease; how they wait upon their queen or queens for the all-important process of egg-laying, collecting the latter and sorting the grubs

according to age and sex, washing and feeding them, swarming the males and virgin queens in mid-June and so on. We may also witness the fine instinct by which they instantly know stranger or friend even after long periods of separation, how they will fight to the death foes hundreds of times their own size and weight, as well as the marvellous intricacy and mystery of communal action and understanding. For the purposes of this chapter, however, we must regard ants as merely mechanical helps in the aeration of the soil, and in this they are not the only nor by any means the most important creatures.

The premier place in this respect belongs to the Common Earthworm, and this creature probably has a much longer history than that of the ant, certainly an even more valuable one, for, as previously mentioned, we certainly owe the fertility of the soil, and even the soil itself, to the never-ceasing activities of this lowly creature.

When Darwin's attention was drawn to the apparently inexplicable change in the surface condition of certain lands near his home the great naturalist began those patient and laborious researches which eventually gave us his invaluable writings upon vegetable moulds and placed the common, often despised, garden worm high up in the scale of creatures that are of inestimable benefit to mankind.

I have known amateurs who thought they were doing themselves good service by destroying worms, arguing that they eat away the roots of plants and are therefore injurious animals. This is an entirely erroneous notion. I do not say that worms cannot or never injure roots on occasion, especially if they be confined by accident in a small space, say in a flower-pot or window-box. Indeed worms are omnivorous, most things that come in their way are acceptable, including roots and fibres. But they are more commonly addicted to the chewing up of odd leaves lying about on the surface, consuming

with them large quantities of soil, and in any case the value of their services is out of all proportion to the small amount of damage, if any, that can be laid to their charge.

The Common Earthworm (*Lumbricus terrestris*) belongs to the first class of articulated animals, the Annelides, which are the only invertebrates that have red blood. Most of them live in the water, the Earthworm itself being an exception to the rule. The Annelides are divided into three orders, (1) The Mud-worms and Sea-worms, (2) The Sand-worms and Sea-mice, (3) The Earth-worms and Leeches.

Worms have neither eyes, gills, tentacles nor teeth. The digestive process is carried on by means of a gizzard, and they swallow for this purpose large quantities of earth and grit along with the odd leaves, roots, fibre, decayed woods and animal matter upon which they subsist. When fullgrown the common earthworm attains a length of nearly a foot. The breeding season is in the month of June and propagation is by means of eggs, which are sometimes hatched within the body of the parent, and sometimes laid in their burrows where the young ones subsequently appear. A drawing is shown of both the adult and eggs, with young therein, the latter considerably enlarged. Figure (*e*) shows the head of a worm, the shape of the mouth and also the bristles on the segments, directed backwards, a contrivance by which worms force themselves along their burrows and through the soil. (See Plate 40.)

Worms are nocturnal in habits, and lie as a rule close to the mouth of their burrows. As stated, they have no eyes, but they nevertheless seem able to distinguish the difference between light and darkness. Darwin considered them to be completely deaf. There is nothing in their anatomy to represent auditory powers, it is true, but there is still a possibility that this may be made up for by some development of instinct as yet unexplained.

The burrows of earthworms penetrate 3 or 4 feet down into the soil in mild climates, and as much as 6 or 8 feet in cold northern latitudes. It is in the constant penetration of subsoil in this way that the great value of the earthworm's service to mankind consists, as they line such burrows with their casts, the latter being the swallowed and digested soil and other matter on which they live. These casts form valuable manure, although the gardener sometimes eyes them askance when they appear on a mild moist morning all over his lawn. Worm casts occur throughout the world, even on the tops of high mountains, such as in the Himalayas, where they sometimes attain great size, 3 or 4 inches in height.

The general result of this constant activity of earthworms, besides aerating, draining and fertilizing the surface mould of the globe, is in addition to change the face of nature, slowly and imperceptibly it is true, but the process is always going on. Great stones left on the top of the ground slowly subside and eventually disappear. This is due to the bringing up of soil from underneath by worms. It has been calculated that this burying action may proceed at the rate of a quarter of an inch a year, so it will readily be seen that although this may seem very little in one season, in the course of time vast changes must be made. Ancient monuments such as Stonehenge and other druidical circles must eventually be completely covered in by this agency.

Worms give great aid to the denudation process carried on by rivers and rain water running down hillsides, as the soil is softened and rendered friable, so that it is more easily carried away to fulfil the purpose of nature in forming eventual new landscape elsewhere. The dark colour of soil is entirely due to worms, who, like most animals, are provided with a digestive fluid which is something akin to hydrochloric acid. The earth from the subsoil level, when swallowed, becomes disintegrated and changed from a bare mineral to a partially organic

substance. The grit that worms take in acts like millstones and grinds the stomach contents up in the same way as is done in the gizzard of a bird. In fact this grinding up of mineral substances, called trituration, is one of the most important operations in the forming of new rocks, and is very greatly helped by the common earthworm, whose activity is anything but negligible geologically, apart from what is to us as growers, of more immediate benefit in the way of soil formation.

It will thus be seen that were it not for the common earthworm there would have been very little soil for plants to grow in, and I would also observe that the hills and dales which look so solid and immoveable to us, are by no means permanent features, as they change from year to year by these seeming small modifications wrought by apparently insignificant creatures like the garden worm.

Having our soil thus prepared for us as a bountiful gift from the hand of nature, we must endeavour to carry on as much as we can a perfectly natural process of growth. Wherever we depart from this we are bound to discover, as years go on, that too heavy cropping means soil exhaustion at a rate greater than is made up for by the ordinary restorative action. The making good of such a state of affairs is called manuring, and I propose to conclude our present programme in the chapter that follows with a few notes on that subject.

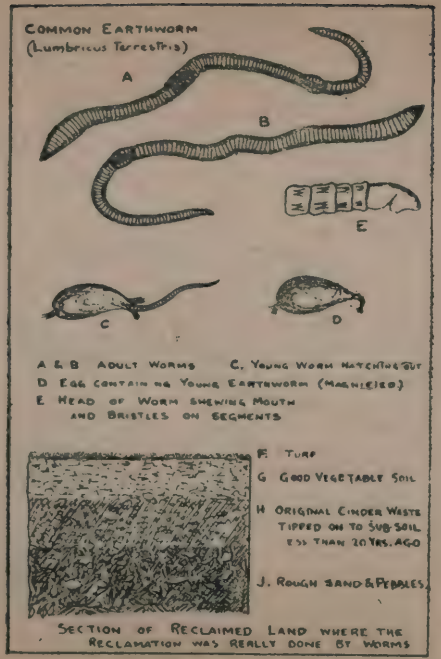

PLATE 40.
Beneficial Work of Earthworms.

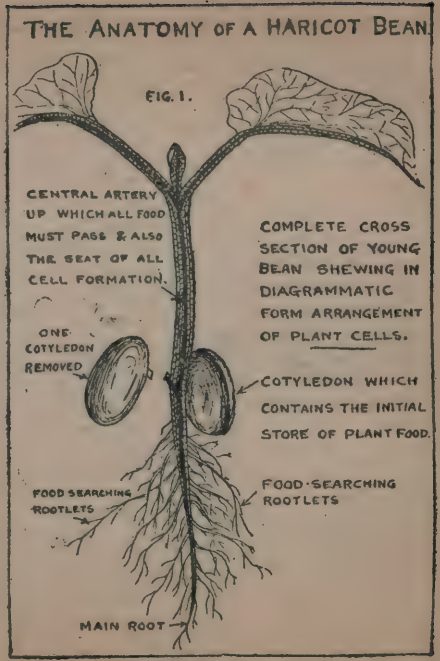

PLATE 41.
A Lesson in Plant Mechanism.

CHAPTER IX

THE CHEMISTRY OF MANURES

How a plant feeds and grows—The word "manure" or "manœuvre"—The earliest form of "manuring"—Organic and inorganic manures—Manures for various crops—Green manuring and fallowing

THIS is to be a short chapter on manures, again from the point of view of the "why and wherefore" of the subject, and for this purpose one is bound first to consider the problem of plant life and growth. In fact the question of manuring is only understandable by first examining the internal mechanism of a plant, so that we may see what actually goes on before that perennial miracle, growth, can take place.

As an example let us take the common case of the Haricot Bean and try to grasp the process of its development from start to finish. I should like the reader to imagine that the figure shown in the accompanying drawing represents a young bean which has just got its first pair of green leaves, and we are further to suppose that we have taken a sharp razor and sliced the plant straight down the middle and are looking at its interior cell structure. It is true that each cell has been drawn about one hundred times its natural size, but that is a necessary convention, the reason for which is obvious. (See Plate 41.)

To begin with, then, the process of growth is the process of the formation, renewal and decay of these

little cells. All plants and animals are built up of cells, which are constantly wearing away and as constantly being renewed and increased. When the creature fails to renew its waste tissue, it dies and falls into complete decay, reverting to the original elements. It is therefore vital that this renewal and re-forming of cells should be understood and assisted in every way. Cells are filled with protoplasm, a mucous or gelatinous substance composed of water, carbon, nitrogen and sulphur, which Huxley called "the physical basis of life." This applies to both the animal and the vegetable kingdoms. Vegetables are, however, distinguished from animals as a rule by the fact that their cells are always enclosed in a definite and comparatively solid box or cell-wall, made of cellulose, the raw material out of which every plant structure, from the tiniest blade of grass to the noblest cedar pine, is built. Cellulose can be chemically reduced to merely carbon and water, although no scientist has yet been able to change these elements back again into cellulose. The same remark might of course apply to cane sugar, which is of exactly the same composition, and if it had been easy to recompose it we should not have had to present our grocer with a carefully guarded coupon week by week, but that is by the way.

We see then that plants are mainly composed of the elements Carbon, Hydrogen, Oxygen, Nitrogen and Sulphur, and if we think of the initial letters of these substances, C.H.O.N.S., it will help us to remember it. There also occur small traces of Iron, Magnesium, Phosphorus, and Salt (sodium chloride), as well as Silicon. These are the I.M.P.S., which dwell in the soil, and good little imps they are, for when the ground is properly tilled, the oxygen from the air combines with them to form important plant foods.

Now, how does a plant feed? Here is our bean growing away merrily, if you like, in an observation

box with a glass side to it. Suppose we detach one of the tiny rootlets, and examine it, after splitting with a razor, under a powerful microscope. It will appear like Figure 2. Notice how the cells marked (*a*) have got worn and flattened down, and how those marked (*b*) are fresh and full. The rootlet had been pushing its way among some desirable substance, which, dissolved in rain water is thereupon absorbed, and such ingredients as are required are passed up the central "staircase" of cells which are ranged in the form of a tube from the merest tip of a rootlet to the leaf vein itself. The worn cells at the tip simply remain as a protection whilst the rootlet pushes its way in and about the particles of soil. If we were to sever the central "staircase" just spoken of, the plant would either die or lead thereafter a much restricted existence. Enterprising insects like the Turnip Gall Weevil know this well enough, as we have seen, and with generous self-sacrifice they religiously avoid the "winding stair." (See Plate 42.)

We must not, however, conclude that plant feeding only consists of sucking up sustenance from the soil by means of the roots. This would be a great mistake. The purpose for which a plant has roots is as much to hold it down in the soil as it is to draw goodness therefrom, otherwise our cabbage and lettuce would be playing skittles in the first high wind. Before a plant can successfully progress it must perform many other important functions. For instance, it must breathe, for which lungs are needed; keep its blood in circulation, requiring a heart; it perspires through the skin, digests its food within a stomach; and then must ensure a place in the next generation, for which in addition it must exercise arts of coquetry second to none in the scheme of creation.

Glancing back for a moment at our plant analysis, it should be mentioned that the first four elements, which as we said were the main constituents, come entirely from the atmosphere and from the oxygen and hydrogen (as

water) drawn up out of the soil. The plant can, from the mere appropriation of these substances, grow from a small and simple seed to a great and complex community of specialized cell structures. How is it done? Is a plant (or an animal) the only thing that grows? What about a snowball which rolls down the hill and commencing at about the size of a dumpling, becomes large enough to floor a bullock! Or suppose we visited one of those curious places called "dropping wells" and placed an old flat-iron or other object therein, returning in course of time to find it not only apparently changed to stone, but actually grown in size. Or take as a more ready instance the beautiful "ferns" drawn on the window-pane by Jack Frost in a single winter's night, growing in that short space of time with marvellous variety and profusion.

Are these cases at all comparable to the growth of a plant? Clearly not, for there is one striking difference, viz. that whereas all mineral substances, snowballs, crystals, sedimentary deposits or what-not, "grow" by additions of the same substance on the *outside*; plants (with animals) take into their "winding stair-case" on the *inside* all manner of different substances and convert them into cell material. This at once indicates the gulf that divides life from inert mineral matter, for the crystals and the lime deposits were merely accretions, whilst the plant or the animal performs a miracle which we cannot explain, and we call it the miracle of growth.

We said that plants must breathe by means of lungs. Well, look at the enlarged plan and section of a portion of the bean leaf. The numbers of little mouths or pores (called stomata) take in air during bright sunshine and it passes into the little chambers marked (*c*) which occur all through the plant structure, where carbon is extracted and oxygen given off, exactly the opposite of the breathing process in animals, so that the leaves are in every sense of the word lungs. They also act collectively as a

heart, for the veins and arteries of a leaf carry up and down sap and nutriment, and can only do this in response to the movement of the young buds which first begin to respond to the magic of spring sunshine, when the sap hurries to their aid and expands them into full-sized leaves. Again, the surfaces of leaves are closely analogous to the skin of animals, for they absorb or exude moisture in varying degrees by opening and closing the stomata spoken of according to the changes of humidity and temperature. (See Plate 42.)

Furthermore the leaves act as a stomach inasmuch as they take in the nutriment sent up by the sap and accept or reject the items on the "menu" as the case may be, the rejection, chiefly water (there does not appear to be a wine list), being got rid of as mentioned above.

How does the plant and its leaves perform all these things? It is of course largely a mystery, but turning again to our leaf section on Plate 42 we see that the inner cells are filled with some substance shown dotted. This is chlorophyll or plant green, which has been mentioned before, and in it lies the clue to our plant miracle, in all probability, for it has been proved that chlorophyll has a strange power of selection and analysis over the gases and liquids which come to the making of a vegetable structure. The cells shown in white on the top of the leaf, forming its covering, are simply filled with air and are transparent. The green flesh of the leaf shines through, much as in the case of an albino, like a white rabbit, where the eyes, being devoid of pigment, appear to be pink on account of the blood that shines through them.

It is chlorophyll which enables a plant to feed upon inorganic substances, but this material also co-operates with the sun's rays and is in fact rather like a storage battery which absorbs the energy that pours down from heaven in beams of light on a bright day, so that fermentation soon takes place all through the leafy structure and down the "winding stair" of the plant, which thus grows

by reason of its power to convert the various gases and dissolved mineral matter into new cells within itself and not on the outside as we saw in the case of minerals. These cells are a paradox to the mathematician, for they multiply themselves by simple division! The cell-wall contracts and parts off the protoplasm into two portions, each with a nucleus or life-centre, and the two halves, instead of wandering about in search of each other, as Plato said of human beings, straightway proceed to become full-grown cells and perform a similar function in their turn. In fact it does not matter which of them considers itself the "better half," as the other one can turn round and say "You're another" and still keep the peace. But the process of cell division does not go on indefinitely, the cells act as though they were buyers of raw material and take from their central market, the sap-stream and the atmosphere, just what each requires, some to build new cells as described, and some to pack their insides with corky or woody material so as to form a hard stem, some to store up starch and sugar, and still others are diverted to the business of flowering and reproduction.

This last is the most interesting process of all, and plants present an endless variety of method and device in order to secure continuance of their kind in the next generation.

The habit of the plant determines its leading characteristics. For instance in the little nursery poem which runs :—

'Down in a green and shady bed, a modest violet grew;
Its stalk was bent, it hung its head, as if to hide from view.
And yet it was a wondrous flow'r, with petals soft and rare,
It might have graced a lovely bow'r, instead of hiding there.
Yet there it was, content to bloom, in modest tints array'd,
And there diffused a sweet perfume, within the silent shade.
Then let me to the valley go, this pretty flower to see,
That I may also learn to grow in sweet humility."

Here the little violet chooses "a green and shady bed" because it loves coolness and moisture, but in order to let the world (or the bees) know that it is there, the flower must not carry its "modesty" too far. Hence the "sweet perfume." The violet, i.e. the sweet violet, is one of those flowers which employ a fragrant scent as an attraction to insects for cross-fertilization purposes, whilst its cousin, the dog-violet, just grows boldly on the hillside in full sunlight, and has no scent. Other flowers depend on their brilliance of colour, like the poppy of the fields, "all silk and flame." Some of them mimic the outline of a butterfly, such as the peaseblossom, whilst "the flowers that bloom in the spring, tra-la" are nearly always yellow in colour because yellow reflects the greatest amount of light, and so shows them up for as long a period as possible at a time when the days are neither lengthy nor bright, and insects are few and far between. Again, there are flowers which have neither scent nor brilliance of colour, as, say, flowering ivy, lime, and fuchsias. These are more richly stored with honey, as the bees soon discover, and which is taken by them as wages for the work of pollen mixing. Lastly there are flowers which are not so dependent upon insects, as tomato-bloom, garden poppies and others. In these the genital organs are placed so close together that the waving of the plant in the breeze or a gentle shaking by the human hand will ensure the pollen adhering to the desired spot and the germination passing down the tubes of the pistil into the ovary itself.

All these are devices directed to one end, viz. the carrying on into the next generation, and as we see again, Nature proves herself here also to be the grand mistress of arts and crafts. If she cannot get what she wants by asking, she will take it. If she cannot take it, she will go and flatter somebody else until the thing that is really wanted comes of its own free will, so what *are* you to do?

Different plants feed on different constituents in the

soil and in varying proportions. It is clear then that what is poison to one may be rich provender for another. This is where the question of manuring comes in. We must judge, by making experiments or by utilizing the experience of others, what proportions and what constituents are necessary for each kind of crop.

Originally the word "manure" was simply "manœuvre" and referred to tillage rather than to the feeding of the soil. Shakespeare speaks somewhere of the mind being "manured with industry," meaning the application of exercise, and not superphosphate, to the brain-pan.

Minnehaha, the bride of Hiawatha, was the first Land Girl. She used to scratch about the little crop of Indian maize with a pointed stick because she found it improved the growth. In that simple picture you have the beginning of agriculture, so that the Land Girls of to-day have merely gone back to their old love after all, and let us give those early land girls credit in this, viz. that whereas men first thought of killing, it was reserved for the women to inaugurate the first of the arts of peace.

But then, the mere working of the soil soon became totally inadequate for the permanent raising of crops, as was found to be the case in the Southern States before the American Civil War. In fact that war itself was caused simply because the settlers were too lazy to manure their cotton plantations. When the land gave out they just shifted on to virgin soil elsewhere, and thus came at last into contact with their northern relations, bringing their slaves with them. The northerners did not believe in slavery, and the southerners did, and were determined to keep them. Then the fun began.

No, land is limited in area, very much so in England, and we must always renew the store of plant food as we go on from year to year. This is done by the well-known rotation system, by which one crop indirectly provides the food for the next, and also by adding manures.

Manures are of two kinds, organic and inorganic. The

former are principally provided by the dung of animals and birds, sewage from towns, meat, fish and vegetable refuse, blood, fat and other slaughterhouse waste, horns and hoofs, etc., bones, fossils, hair, shoddy, seaweed and so forth. The inorganic (or artificials) are mostly chemical by-products, the number of which increases from year to year, and they all come under the main headings, nitrates, phosphates, sulphates, potash. These comprise together all the foods that plants need out of the soil.

One cannot in a short chapter like this deal with the composition of all these manures, but I have endeavoured to show that the chemistry of the plant and the chemistry of manures are two very intimate things, and if we succeed with our crops it is because the right food and only that is available at the right time. In our little study of the mechanism of a plant we saw that all the soluble salts and other food must pass up the central artery. Now the discrimination is not done by the roots. It is true they wander about to find sustenance, but they simply have to absorb whatever they find themselves in. In other words, all sorts and conditions may come in at the box office, but the choice lies with the authorities up the "winding stair." If a green crop wants nitrate, it is no use for the Chairman of Superphosphates Ltd. to come bursting in with an urgent message. The answer simply is, "Can't see you, sit down and wait for five or six months, and then we'll talk it over."

It might be supposed that we could grow a crop as many times as we liked on the same spot by just giving it what it wanted in the way of manure, but whilst this is not impossible, it is found best in practice to follow the rotation principle. The following little tables show how in general this may be worked out, and although the question of rotation is generally considered a matter for the farmer only, I have always thought it could be advantageously applied by small allotment-holders to a greater extent than was done during the war, especi-

ally if they intend to fight for a permanent place as food producers. With small plots one can only rotate satisfactorily in concert with one's neighbours, and therefore closer association is needed in this respect as well as for the obtaining of other co-operative advantages.

FARMERS' FIVE YEAR ROTATION TABLE WITH FALLOW.

Field	Crop.	Manures and Treatment.	1st Year.	2nd Year.	3rd Year.	4th Year.	5th Year.
A	Wheat, Oats or Barley	Clean land and dress with guano or sulphate of ammonia	A	B	C	D	E
B	Clover or Greens	Dung, guano, nitrate or soot	B	C	D	E	A
C	Roots .	Winter dunging . .	C	D	E	A	B
D	Beans . .	Clean soil, bone or potash dressing .	D	E	A	B	C
E	Fallow .	Sow with tares, turnips or vetches, Potatoes are also grown	E	A	B	C	D

ALLOTMENT-HOLDERS' FOUR YEAR ROTATION TABLE WITHOUT FALLOW,

Plot.	Crop.	Manures and Treatment.	1st Year.	2nd Year.	3rd Year.	4th Year.
A	Potatoes, Onions	Clear ground and winter-dung . . .	A	B	C	D
B	Cabbages, Greens, etc.	Fresh dung or nitrates	B	C	D	A
C	Roots and Celery	Phosphates or winter-dung	C	D	A	B
D	Beans and Peas	Clean soil, potash or bone	D	A	B	C

The above tables show how the farmer and the allot-

ment-holder can keep a record, by lettering his fields and plots on a plan of the holdings, of the necessary change of crop which will give the soil the advantage it would enjoy in a state of nature. This does not mean that rotation goes on in nature, as vegetation there completes a perfect circle within itself for each plant on the spot where it grows, whereas mankind, in robbing the soil of so much starch, sugar, etc., and being rather careless about putting its equivalent back again, must find a ready method of ensuring soil health. This is done in part by the rotation system, as soil formation and the provision of soluble salts go on interminably, and one crop will leave behind the bulk of the minerals and salts suitable for another crop, which can therefore follow it, but the balance must be made up by manuring.

Corn land exacts the greatest toll of plant food from the soil, and so requires the largest amount of manure. As a matter of fact wheat will grow on ground that is merely well tilled, but not manured, but then the yield in no way compares with ground that has just been under clover or vetches and is tilled and dressed with guano or sulphate of ammonia.

Clover or green crops should follow wheat or other corn to hearten the ground up again. Dung can now be applied for greens, or for clover give guano, soot or nitrate. The next crop may be roots, such as mangold, turnip, swede or potato, with winter-dunging to ensure complete incorporation with the soil. The following year the ground may be cleared, given a light dung dressing or else superphosphate or bones with potash, and beans may be grown. The fifth year should see a fallow, i.e. a resting year when the ground is sown with lucerne, vetches, turnips or mustard, to form eventually a green manure. Sheep are often run on to the ground in order that a certain amount of forage and soil enrichment may be got at one and the same time, after which the crop is ploughed in. Soil thus treated completely renews its youth, although in

these strenuous days the green fallow is usually replaced by a potato crop, which is regarded by many farmers as a cleansing crop for the ground, which then becomes available for wheat again.

In the previous chapter mention was made of the importance of lime in all soils. Lime is produced by heating chalk, limestone or marble, all of which are of the same chemical composition, viz. one part each of calcium and carbon to three of oxygen, called briefly calcium carbonate. When the chalk, which is the cheapest substance, is heated, carbon di-oxide is given off, leaving the calcium oxide or quicklime behind. This, on being slaked with water or exposure to the air, is applied to the soil. The result is that if the ground be sour and contain an excess of carbon di-oxide from long stagnation, the lime, which is always attracting this gas in its desire to go back into chalk, sweetens the soil in the process. It should be remembered that although carbon di-oxide is a plant food, it is in the wrong place down in the soil, plants breathing in air through their "lungs" (the leaves) and extracting all the carbon they need above the surface. Beneath it we must endeavour to keep a good circulation of sweet air going, to enable the oxygen to continue its life-giving work by uniting with the elements in the soil to form carbonates, phosphates and nitrates, thus rendering them available for the support of plant growth.

CHAPTER X

CONCLUSION

General remarks on the insect pest question and how to regard it—A small section of the great and universal process of parasitism. The pig and its tapeworms an example of the complexity and resourcefulness of pests—Cooking the cause of the general immunity of human beings—A conclusion as to the real motive of parasitism. Nature study, vigilance and co-ordination of preventive action and methods the best means of protection for the farmer and small-holder

WE have now brought our long catalogue of small life-histories to a close. It is obvious that out of the countless cases we have had to choose from only a comparatively brief selection could be made, some of which will be more familiar in one part of the country than in another, whilst there may still be examples not here dealt with which some people have found a trouble to them. I can only now refer them to larger works, and propose to conclude the present little volume with a few general remarks on the principles which underlie the pest problem, which I hope may be of service to the reader.

How ought we to regard the pest problem ? We have seen in the foregoing pages the ubiquity of insects and allied pests ; their resourcefulness ; their vast numbers and variety ; the causes of their sudden and unexpected appearances in plague proportions ; and we have considered hosts of remedies. As to the last point, I should like to say here that I hope no reader will set to work to purchase and use *all* the artificial remedies mentioned in this book and elsewhere, or he will take the gilt off the

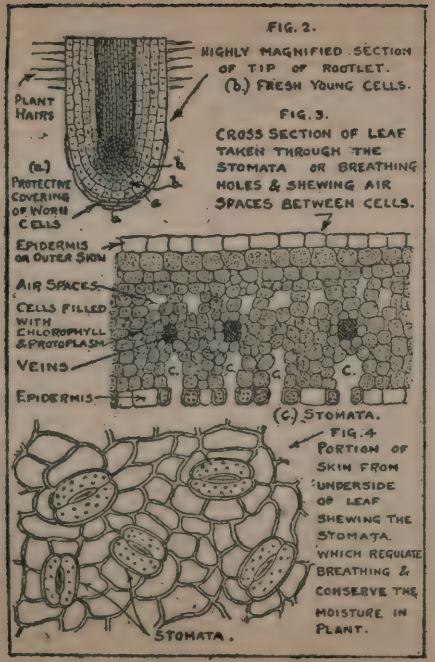

PLATE 42.
Sections of Leaves and Rootlet.

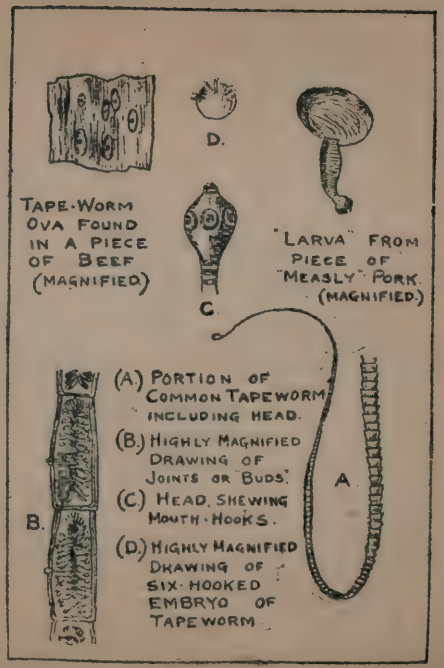

PLATE 43.
Pig Tapeworms.

gingerbread of his profits long before any pest appears on the scene. I find, too, that this is quite a common view of farmers and growers in relation to pests. They say, "Yes, but you can't spend that amount of money, or devote that amount of labour, on fighting pests. The pests had better by half take what they want and go." Precisely, although the question of artificial remedies becomes a more practical possibility to the small cultivator and the allotment worker. Yet in all cases readers will find that I recommend them to look at the thing from an economical standpoint, and above all to examine the life-history for themselves and to seek out the *natural* remedy or method of control, which latter I have always emphasized the importance of.

Now the question of pests as a whole is only one small section of the vast and universal subject of parasitism. It will be remembered that I have described how pests have constantly appeared to be invested with the actual power to determine the continuance or not of a species on the earth, at least to determine its change of form. This may not be actually so, although readers of that thoughtful book, *Mosquito or Man*, wherein are recorded the researches of Sir David Bruce and others in Nigeria, will see that there is something more than mere surmise in such a suggestion.

We have spoken of the ubiquity and resourcefulness of pests, and have seen in the case of the liverfluke in Chapter II the extraordinary expedients by which they manage to secure a place in life for their progeny. We have almost as good an example in the case of the Common Tapeworm (*Tænia solium*) which forms such a strange link between human beings and the Pig. The repugnance of eastern nations to the eating of pork and the flesh of other "unclean" animals is more than a religious ordinance. It arose from a correct estimate of the penalty often paid for partaking of an unnatural food. After all said and done, we were *meant* to be vegetable and fruit-

eating creatures, and could if we tried find all our sustenance from such food without eating meat. Every kind of animal food may contain the ova of some kind of tapeworm. The dog will get them from eating the raw flesh of sheep, the fox from the rabbit, the cat from the rat and so on. At the same time there is no need to go to the fanatical lengths of the vegetarians. If we were *obliged* to live in the forest in a primitive state, we should also be obliged to eat nuts and to climb trees to get them. The parallel need not be enlarged on. On the other hand we can easily eat too much meat, which is a powerful stimulant, and if we eat it " under-done " there is great danger of tapeworm ova being taken in while still retaining their vitality. The discovery of fire and cooking is, therefore, civilized man's chief protection against these plagues, although it causes his teeth to decay prematurely from want of use. The habit of eating raw sausages and ham, as done by the Germans, brings its own penalty in the fact that they suffer more than any other nation from these ills.

What really happens in the case of the Common Tapeworm is as follows :—The creature is strictly speaking a collection or colony of semi-independent animals, every " joint " or " bud " being complete in itself and containing a vast number of eggs. The head, which is very small, embeds its mouth-hooks in the intestinal wall and nourishes the whole concern as well as forming fresh " buds " almost *ad libitum*. When these are mature they are released and the eggs subsequently dispersed, some of them eventually finding their way into the pig's body. There they become " resting-larvæ," and bore right into the pig's muscles, brain or other organ, and are not a bit like the full-grown worm.

If the pig died a natural death and was buried, these larvæ would never develop. When, however, pig becomes pork and is eaten in a partially cooked state, these resting larvæ soon establish themselves in their new surroundings

and become complete tape-worms to continue the budding-process as before.

A drawing is shown of the various stages of development whereby this creature secures its continuance in life at our expense. The long odds against it are made up for by its extreme fecundity, as in the case of the liverfluke, each "bud," of which there may be 1,200, containing some thousands of eggs. (See Plate 43.)

Parasitism has always been going on through the ages, and we are only just beginning, as it were, to feel our feet in the matter. Its range is quite universal and its ramifications so endless that I cannot attempt anything but a general assertion here. The study of parasitism and that of evolution should be braced together; in fact they will coalesce of themselves without any help from us. When the early naturalists found, say, ova, larvæ or embryos of hitherto unknown forms of life established within the bodies of worms, fishes, birds or mammals quite unaccountably, they propounded the theory of spontaneous generation, somewhat in the same way in which it was at one time believed that showers of frogs came down in a thunder-storm. This idea is now considered to be exploded, although I think it is a dangerous thing to be dogmatic, particularly in regard to natural history, seeing that so many arrangements, classifications and settled convictions have been turned upside down in the past. We have, however, at least traced out the real origins of parasites then thought to be actually brought into being by the host in question.

For instance, we human beings, dreadful as it may sound, have to our name no less than 120 different species of parasites, including nematoid, cystose and intestinal tapeworms and flukes; acarid mites; crustacea; dipterous, suctorial and mallophagous insects; most of them fortunately of rare occurrence, but which would certainly develop a very absorbing interest in our personal affairs if we did not take stern measures to keep them at arms'

length. Nowadays nobody would willingly believe that all or any of these repulsive creatures could be brought into being by a long-suffering biped of the genus *homo*, and indeed it has now been established that the air we breathe, the water we drink, the dirt that gets on our hands, and the food we eat, simply teem with microscopic spores, ova and minute embryo forms which under favourable conditions might produce a serious state of things for an unfortunate victim. Then the number of species of parasites is hugely in excess of the number of hosts, so that a terrible struggle for existence between the two great classes is always going on. Incidentally there is a borderland or neutral zone between them, where parasite and host live together on equal terms ; as, say, the hermit-crab and the sea-anemone. This we call the "mess-mate principle" where each is indispensable to the other. Whether any such settlement of the pest question can come about as a whole I am quite unable to say ; but if so, I suppose caterpillars would have to be rationed, and the marriage lines of butterflies officially approved by the Ministry for Nature ! For the present we can only take our share in the great struggle, which is what we are here for. The reason why a negro has a thick skull and an ebony skin is because his forebears fought and won a battle against the fiercest sunlight that pours down on this earth. The white man, pith helmet notwithstanding, will never conquer Africa in that sense. He may, however, teach the negro not to live in squalor and dirt, uplift his mind and civilize him, although there are wrong as well as right ways of doing that. The point is that we humans, whatever our race and creed, are all liable to the constant and unending change that is going on from age to age all through creation in accordance with the change in the environment. This determines the character of both pest and host, and both alter from year to year imperceptibly, but with a distinct tendency all the time for one or the other to predominate. Take an ex-

ample. A certain two-winged fly, ages before the flood was happy enough buzzing about the forest glades of the primeval world. It was carnivorous in appetite, and very partial to animal blood. Then cold times came and life was a serious matter for many folk, the fly included. On one auspicious occasion it nestled close up to a shivering biped, and liked itself immensely on finding a cosy place at last. When times were better and there was an opportunity to resume its former life again, this inconsiderate fly said to itself, "Well, I don't know, I rather like this chap, he's quite a warm customer. After all, who wants to buzz, when there's a nice ante-diluvian armpit to live under?" So, from being driven under the said armpit by necessity, it took to staying on by deliberate choice, and then, as everything useless or neglected in Nature is ruthlessly scrapped, the fly lost its wings, could not revert to its former life, was now *dependent* on the biped, and there you have a common flea! It is strange to think of it as spinning and humming around in those bygone days, no doubt having to be flicked off our grand-great-grandfather's nose, but it is perfectly true that fleas have degenerated by the very means they adopted to save themselves from extinction, becoming in the process a nuisance and a menace to a higher being. This kind of thing is always going on, and to my mind is working out some plan, or at any rate will arrive at a fixed result which we have yet to guess at and to further if we can. There have been controllers galore in the late conflict of nations, but they all pale into miserable insignificance beside the great control that does in truth hold the future for us as it were in the hollow of a hand.

It used to be the fashion at one time, in Victorian times, to feel very placid and detached about life; as a thing that was now definitely explained away as just adaptation to environment or a royal game of chance. How intelligent men, and great men, came to such a

conclusion as sufficient is quite inconceivable to me except on the grounds of mere conceit, and that is not a just charge to make against them. The whole realm of nature simply teems with examples of lovely things which can *not* be explained as only adaptation to environment, which has become a catch-phrase much mouthed by would-be expositors at odd times. And yet adaptation to environment is no fallacy. The secret is that *it is only half the story.* The other half we shall see presently, or at least a humble contribution thereto. Take again one example by the way. The Peacock Butterfly rests with its wings folded on a tree-trunk and no one can see it except with a trained eye. Now this effect may very well have been produced by the constant weeding out of those insects not so darkly marked on the underside through capture by birds and other enemies, but the wonderful coloration of the upper surfaces suggests no mere subservience to utility or protection. Any one seeing this insect alive for the first time, " displaying " itself in full sunlight, will find it easy to believe that here at least Nature has gone into her studio in a divine moment and brought out a work of heavenly artistry. Those gorgeous ocellated spots of blue and fawn, on a brick-red ground, " dazzled " with such daring sweeps of ebony, sepia and white, and wing bases clothed with dusky silken down, are more than a game of chance. Nor is all this beauty a question of sex attraction, as happens in the case of many birds, for both male and female are here alike. Then, supposing we *can* explain satisfactorily the formation of this glorious colour scheme given to a simple weed-eating butterfly ; we have still only described the means to an end as yet unknown. Further, if those wondrous wings could be placed under a high-power objective so that the whole butterfly could be seen at once it is no exaggeration to say that we should remain spell-bound at the revealed grandeur before us. Are we to say that such matchless beauty has been reserved

through the ages until the arrival of the biped with a brain to invent a microscope to discover it? I think not entirely. The unexplored universe just under our eyes has been there all the time, and moreover, since it contains such loveliness often side by side with what in our eyes seems to be such squalor, uncleanness and degradation, then I say that the beauty, as well as the beastliness, must be quite patent to the creatures themselves, or to their spirit motive force, which is about the same thing. We do not invest them with a soul, but the power and the purpose behind them are almost tantamount to it. Our Peacock Butterfly, they say, has more than a thousand eyes in one on each side of its head. Who knows how the present world appears in *its* line of vision? Are those eyes all focussed on one nerve-centre, or do they see infinitely more than is vouchsafed to us? Or, in a lighter vein, may we ask whether the Peacock Butterfly, soaring up the Strand and into the *Smallholder* Offices would see 2,000 Editors busily at work telling the land folk of Great Britain and the Colonies how to small-hold? The fact is, we know so little about this thing, and our opportunity at every moment of time is so great, that this pest and parasite question, instead of being a nuisance, is really one of the greatest blessings in disguise that we have. It is part of the great Nature-drama, containing characters both good and evil. Evil courses will some day be traced to faults and excesses, and to civilisation being at variance with the general plan, so that in our pest problem lies somewhere and somehow, the key to human destiny, to a door which, once unlocked, will open up the golden age, and give to our race what none of us have yet enjoyed, viz. satiety. This is no mere dream of the fancy, although often treated as such. The Eastern seer who told us that the wolf shall dwell with the lamb; and that the lion shall eat straw like the ox, was not telling us of an unreachable ideal, but of a great possibility in the final kingdom of peace. Let us therefore cherish those beautiful things that still remain, even

though we cannot win back those which by our neglect or our greed have been for ever lost.

What then should be done in regard to pests as a whole? As has been already stated. I do not believe in a general essay at an armed offensive for any particular species. We should by preference endeavour to keep ourselves and our stock, our field and garden crops, as close as possible to natural conditions, and interfere as little as possible with the natural balance of life, for there can be no great increase in any one species, be it plant or animal, without a corresponding increase in the control of it in some shape or other. The gist of the matter comes to this, that vigilance, efficiency and naturalization in all things is the surest guide to a better future. On the other hand, neglect of natural functions, "civilized" abuses which are hurtful organically, and production of abnormal types lead to degeneration and extinction, and without wearying the reader or laying myself open to the charge of much moralizing, I should like to wind up by saying that wherever pests occur, nature study is needed, and a little co-ordination of preventive measures or preventive policy as the case may be between man and man will do all that is necessary to prevent a plague.

On these lines we shall avoid the bald mistake of regarding everything in the insect world as inimical, and also of having included in pest books such a glorious insect as the scarce Tortoiseshell or Elm Butterfly (*V. polychloros*), a fine specimen of which was once brought to me by a cousin in the early days when I was on the look-out for what is commonly called "beginner's luck." Yet later on I was astonished to see it given in a standard work as a fruit pest!

Let our cure be, not the listing of enemies, but the enlisting of friends, coupled with the endeavour to secure personal efficiency for ourselves and our progeny, side by side with the like efficiency in all the plants and animals that minister to our support.

THE END.

Appendix

THE APHIS QUESTION

THROUGHOUT the foregoing pages references have been made to Aphids and their ways, but it is felt that the following remarks on this particular insect may be of assistance in combating them.

As soon as a particular kind of weather becomes settled, the great Aphis family make their annual bid for supremacy at the expense of our food-crop.

This well-known but little understood insect is one of creation's mysteries, and without going too deeply into the subject it should be helpful to know something of its history.

Ranging from a fiftieth to one-tenth of an inch only in size and varying according to the species between black, green, yellow, red, brown, and combinations of these colours, aphids afford pretty objects to the microscopist, and in their extreme diversity of habits an absorbing study to the biologist, but for all this the most that a grower will wish to know is how to get rid of them. He may of course go so far as to inquire "What good are aphids?"

For answer I would refer him to the pages of this book, where I have pointed out how the obscure parasite has apparently been "ruling the roost" though really engaged in determining species, be it plant or animal. Growers will readily agree upon reflection that it is the sappy, weak, attenuated plants which aphids crowd on to most, whereas hardy, sturdy plants resist attack. We need not however carry our theory to the dangerous length of visualizing a great Aphid C.-in-C. controlling his armies and despatching them to the ends of the earth according to plan. The exact truth is that the weakly, soft plants have been the means whereby aphids have developed, and in the course of ages the numerous species of plants have led to differentiation in the parasites that affect them.

Indeed it is quite a mistake to suppose that aphids are just aphids whatever plant is in question. There are hundreds of different species, each favouring its own particular plant. When we add the closely related *Psyllidæ* or Plant Suckers, the list alone is formidable enough, but as soon as warm, moist and still weather arrives, their incredible powers of reproduction become well-nigh appalling.

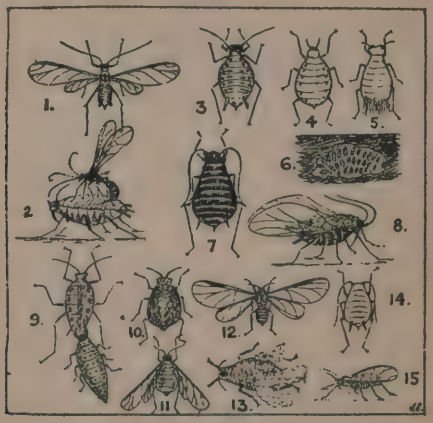

PLATE 44.
Aphides.

1. Corn Aphis.
2. Ditto, attached by Plagiator Fly.
3. Cabbage Aphis.
4. Lettuce Aphis.
5. Ditto, woolly-tailed variety.
6. Lettuce Aphis in soil.
7. Bean Aphis or Collier Blight.
8. Ditto, winged form.
9. Hop Aphis attacked by Lady-bird larva.
10. Apple and Pear Aphis.
11. Ditto, winged form.
12. Woolly Aphis, winged form.
13. Ditto, wingless form.
14. Plum Aphis.
15. Rose Aphis.

Growers and human beings in general would stand little chance of continuance on the earth if the Aphide family were not itself controlled by the great Nature balance which asserts itself sooner or later. Uncongenial weather and hordes of parasitic flies thin their ranks constantly, but the gardener and particularly the flower-lover have to take action on their own account, the farmer being usually compelled to let things take their course.

The commonest kinds of aphids with which we have to deal are the Corn, Cabbage, Lettuce, Bean, Hop, Apple, Pear, Plum, and Rose, which are shown on Plate 44.

As stated the farmer can do little directly against the Corn Aphis, whose Latin name is *Siphonophora granaira*, which has reached alarming proportions in some years, but fortunately for us we have a vigorous little ally in Ephedrus Plagiator, a minute ichneumon which manages to polish off at least 90 per cent. of them. Fig. 2 shows this fly in the act of depositing an egg in the aphid's body, which will soon hatch and devour its host.

The Cabbage Aphis (*A. brassica*) is green with black spots, and infests the undersides of the leaves, causing much loss by sucking out the plant juices and rendering the plants sticky and foul with their excretions. Powdered lime or quassia spray is the thing to use against them.

A more curious insect is the Lettuce Aphis (*Pemphigus lactucarius*) in that it possesses no cornicles or honey-tubes and is subterranean in habit, being a small copyist of the terrible Grape Louse, feeding at the roots of our salad plants. It is yellow in colour and wingless. All ground should be well limed and sweetened to resist its attack.

Much the best-known and worst hated of all plant lice is the Black Bean Aphis or Collier Blight (*Aphis rumicis*), and a field where this insect has really "got home" is a tragedy indeed, for when the tender tops have been destroyed the sooty myrmidons will pass down and thrust their suckers in along the edge of the young pods, which means the end of your crop. Beans must be autumn sown to fully resist Black Aphis, as the plants then become hard and impenetrable, whilst enough pods are formed to admit of the pinching out of the tops.

The Hop Aphis (*Phorodon humuli*) has a good deal more to say on the question of more beer or less than any Government control.

It is pale green in colour with red eyes and would be absolute master of the Kentish fields were it not for the vast myriads of Two-spot Ladybirds which wage relentless war upon them. The extent to which these good little beetles succeed is the measure of our crop, and here again is a case where Nature is recognized as taking a hand in the struggle on our behalf. Fig. 9 in the plate shows a ladybird larva devouring a hop aphis.

Flowers in the garden receive plenty of attention from these

insects and each has its own species, the best known being the Rose Aphis (*A. rosæ*), green in colour and about $\frac{1}{20}$ inch in size. The quassia spray is the best argument with which to meet its attacks.

Fruit is of course productive of special kinds of Aphids, which, with their cousins the Suckers, are responsible for much loss of vigour in both bush and standard trees.

In the Apple Aphis (*A. mali*) the queens or stock-mothers are dark grey, the winged and active forms being green with black heads. The Plum Aphis (*A. pruni*) is green at first and then dark grey when fullgrown. Both kinds have been known to feed on either tree, but they usually keep to those whose names they bear.

Two-wing flies, Lacewings and Ladybirds attack these aphids (see Plate 15), and are of great assistance in preventing their attacks becoming dangerous in the following season, but wherever the twisting and withering of fruit-tree leaves indicates aphis trouble the spray must be kept vigorously at work. Lime-washing in spring also destroys the eggs which are laid all over the bark. Contact insecticides of quassia or nicotine must be used after the blossoms have fallen and in time to prevent the leaf-curl happening.

Neither of these aphids above mentioned should be confused with the Woolly Aphis, which has been dealt with on page 76, and is a different insect entirely, though often as harmful as the two together. It is more abundant where trees have been neglected and attacks both root and branch, and the alkaline winter wash is necessary when the leaves have fallen.

Aphis queens are the most prolific of all creatures, as although the egg is large in comparison they keep on producing them. But in addition to this it has been found that polygamy is practised, a most unusual trait among insects, where one mating usually exhausts the male.

These qualities, added to the ready changes of form by which they adapt themselves to varying temperatures and intermittent food-supply, render it essential that no crop should ever be allowed to fall into a neglected state, so that watchfulness against aphides early in the season is a duty to ourselves as well as to our neighbours.

VIGILANCE CHART FOR USE THROUGHOUT THE YEAR.

MONTH.	WARBLE FLIES.	POULTRY LICE.	WHEAT MIDGE.	TURNIP MOTH.	WIRE WORMS.	BEET FLY.	BEAN APHIS.	PEA WEEVILS.	CABBAGE BUTTER-FLY.	CABBAGE ROOT FLY.	ONION FLY.	WINTER MOTHS.
JANUARY.	Swellings appear.	Lice dormant.	Pupæ in straw.	Larvæ in roots.	Go deep during frost.	Pupa in soil.	Eggs on weeds.	Weevils dormant.	Chrysalis stage.	Pupæ dormant.	Pupæ dormant.	Grease banding.
FEBRUARY	Skin holed.	Lice active.	Examine straw.	Examine clamp.	Lime soil.	Lime soil.	Females hatch.	Clear up litter.	ditto.	Dress lime.	Dress lime.	Females ascend.
MARCH.	Squeeze out bots.	Eggs laid.	Burn infested straw.	Open soil.	Pupate in 3rd year.	Flies emerge.	Eggs laid on beans.	New pupæ hatch.	Early ones out.	Felt Discs wanted.	Work soil.	Arsenic spray.
APRIL.	Apply grease.	Lime-wash houses.	Midges hatch.	Pupæ appear.	Beetles hatch.	Eggs laid.	Pinch out tops.	First eggs laid on soil.	General hatching.	Spray soil.	Flies appear.	Beating for larvæ.
MAY.	Bot comes out.	ditto.	Eggs laid.	Moths hatch.	Eggs laid.	Maggots in crown.	Spray wanted.	Larvæ on peas.	Eggs laid.	Flies appear.	Earth up necks of onions.	Larvæ full fed.
JUNE.	Pupates on ground.	Pyrethrum powder.	Larvæ in flower.	Eggs laid.	Young feed in company.	Salt dressing.	Burn all refuse.	Second brood.	Larvæ at work.	Eggs at roots.	Eggs on bulb.	Pupæ in soil.
JULY.	Fly emerges.	Creosote perches.	Larvæ on grasses.	Larvæ on stems.	Soil fumigation.	Pupæ in stem.	Successive broods.	Larvæ on grass and clover.	Hand picking and sprays.	Larva and pupa stage.	Larvæ in bulb.	Loosen soil for poultry.
AUGUST.	Eggs laid on hair.	Lice active	Pupation	Larvæ on stems.	Larvæ disperse.	Second brood.	ditto.	Adults active.	Second brood.	Second brood.	Second brood.	Employ poultry in orchard.
SEPTEMBER.	Licked off.	Eggs laid.	Burn adjacent weeds.	Roots entered.	Larvæ at roots.	Eggs laid.	Migrate to weeds.	Larvæ active.	Larvæ at work.	Larva and pupa stage.	Eggs on necks of onions.	Grease banding.
OCTOBER.	Bot penetrates gullet.	Lime-wash wanted.	Pupæ in straw.	Feeding continues.	Larvæ at roots.	Maggots in crown.	Winter Queens fertilized.	Larvæ feed in winter.	Salt wash, etc.	Pupæ in soil.	Larvæ at work.	First moths emerge.
NOVEMBER.	Larva in beast.	Creosote perches.	Examine straw.	Larvæ at work.	Gas lime.	Pupæ in soil.	Eggs laid on weeds.	Adults dormant.	Destroy chrysalids.	Gas lime.	Gas lime.	Females ascend trees.
DECEMBER.	Swellings appear.	Lice dormant.	Burn infested straw.	Larvæ dormant.	Larvæ go deep in soil.	Gas lime.	Winter egg stage.	Clear litter.	Destroy chrysalids.	Pupæ dormant.	Pupæ dormant.	Eggs laid.

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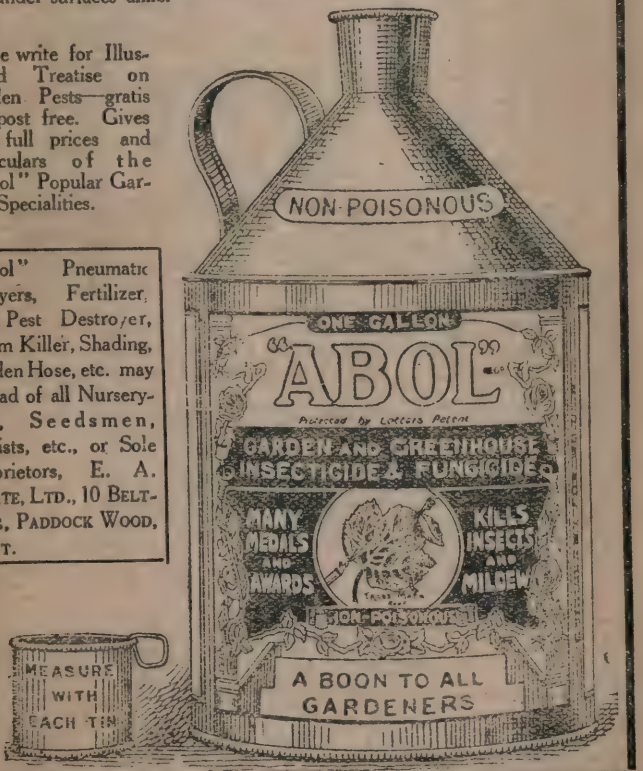

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